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An Illustrated Weekly Journal

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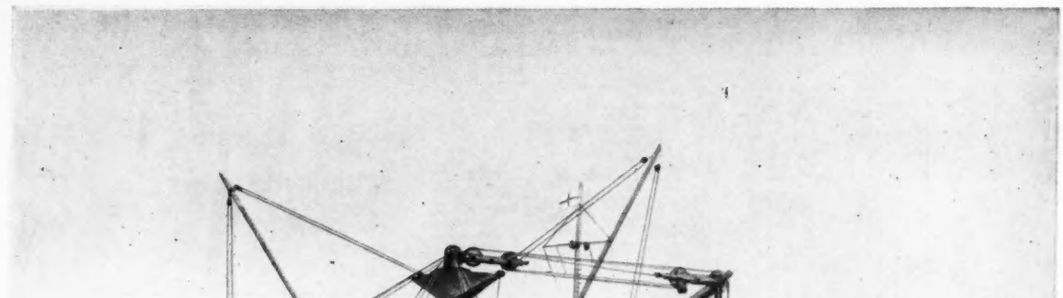

THE STEEL TUBE AGE

Unloading the forward section of a small prefabricated ferry vessel at Lagos, Nigeria, by means of a tubular steel derrick supplied by S & L.

The derrick, tested to lift 150 tons, was installed on the Elder Dempster Lines Limited vessel, *Onitsha*, by the shipbuilders, Harland & Wolff Limited.

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ENGINEERING

An Illustrated Weekly Journal

Vol. 182 No. 4716 JULY 27, 1956

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ASWAN AND KARIBA

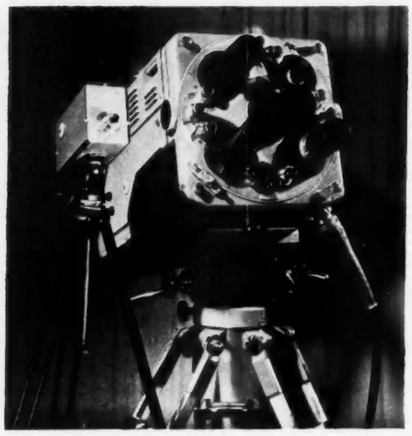
AFTER sitting on the fence for six months, Colonel Nasser sent his envoy to Washington with the message that the Egyptians were willing to accept the offer of a loan from the United States, the United Kingdom and the World Bank to assist with the construction of the High Dam at Aswan on the Nile. The United States, followed by Britain, replied that they were no longer interested in providing financial assistance for the project. The whys and wherefores for the rebuff are primarily political—Egyptian refusal to share the stored water equitably with the Sudanese, the overtures to Russia in hope of better terms, dissipation of Egypt's resources on armaments and other forms of industrialisation so that she is unable to meet her own share of the cost of the dam, and finally her general attitude of trouble-making for the Western Powers in the Middle East.

Recriminations in respect of the loss of the Kariba contracts have been widely publicised through the national Press. Various explanations have been advanced for the small part British firms are to play in building the £25 million dam and there has been only a slight element of relief that other British companies have or will receive orders worth £10 million for equipment. It seems to have been completely overlooked that supplying equipment—turbines, generators, transformers or transmission towers—will be more profitable to the British national economy than the organising of native labour and transmuting Rhodesian rocks into the arch dam required.

Nevertheless, Kariba and Aswan—should the latter be built—are only among the first of a series of very large projects required in the underdeveloped territories and British firms should be organised so that they can tender on grounds of parity with consortiums from the Continent, the United States and elsewhere. No single British contractor is large enough to have tendered for Kariba without joining forces with some other contractor. That British contractors were interested in Kariba there can be no doubt. It is almost certain that of the five tenders put in for the dam only the successful Italian Impresit group did not include a British partner; but it is almost equally certain that not one of the groups was wholly British nor even predominantly British. There can therefore be very little complaint in any circles that the British Government did not make official representations to the Rhodesian Government that the tenders of certain groups should receive particularly favourable review.

What is required of a contractor to be successful in bidding for international tenders of this magnitude? The way of the company that undertakes large civil engineering contracts overseas is tough going. It is probably true to say that of the British firms operating on a considerable scale overseas before the war only one or two are still in the business on a comparable scale. Of the others now successfully completing large contracts overseas, several did not exist 20 years ago or at best had only been concerned in relatively minor works before the war. The Impresit group, on the other hand, was founded in 1929 with the object of encouraging and co-ordinating the activities of Italian firms in carrying out major works in foreign countries unembroiled with small "bread-and-butter" jobs. It derives considerable financial strength from the Fiat Motor Company and from the experience of its members in building hydro-electric works in Italy. The group has undertaken extensive dock work in Lisbon, railways in Persia, and roads and other works in France, Nigeria and Eastern Africa. But experience alone does not win contracts. A low bid is still the surest way of being successful. In regard to Kariba, the Italians asked about £1½ million less than their nearest competitor, believed to be an Anglo-American group. The difference between the bids has been attributed to the lower level of wages and accommodation accepted by Italian labour, so allowing the use of a higher proportion of more productive white labour as compared with native labour than was permitted to the non-Italian groups. If this is in fact the case, though official Italian circles have been at pains to deny the suggestion, it will not help British companies to throw in their lot with American firms. Nor is it helpful to buy expensive American construction machinery, especially as the same or similar equipment can now be obtained from British manufacturers.

Over the past two years or so British civil engineering contractors have succeeded in increasing their overseas order book from an annual figure of £50 million to something like £70 million, about 60 per cent. of which is in the Sterling area. Work at home is currently £1,200 million per annum. Of the overseas work, six firms contributed over £3 million each and six others over £1 million each. It follows that winning a contract valued at £25 or £30 million and planned to be completed within four or five years is by no means outside the capacity of the industry as a whole. Britain's standing in the world could be raised appreciably by the successful execution of such works. Much good work is already being done by individual firms; so much more would be possible if in future they combined and tendered as a British group.



Marconi's industrial television camera is more compact than the Mark III "entertainment" unit.

* * *

Plain Words

Lord Beveridge concluded after the war, on the basis of a detailed survey of British industry, that 3 per cent. unemployment was a highly satisfactory figure for a state of full employment. To-day unemployment stands at less than 1 per cent. of the working population and has done so (with minor variations) for three years. Managements are terrified to adjust their labour force to their needs and a ludicrous but common situation is of a company holding on to half-employed workers while a less wealthy neighbour is unable to get enough.

Some who had the temerity to unload workers (in 1952-53) found that they could not get them back as trade picked up. Then there is quite another aspect: workers are obsessed by the fear of the sack; redundancy is abhorrent enough a word to force responsible trade union leaders to call 48,000 workers out on strike. So we have it both ways—management will hang on and under-employ until they can no longer afford it—workers will oppose any sacking for lack of work in a particular place by a strike as widely based as possible. Obviously this situation makes for inflexibility, which in turn militates against industrial growth and adaptation to technological change.

What *The Times* calls "the rigid State" is with us, and it is not a good competitor for world markets. It may be a realisation of this, or it may be sectional interests, or an eye for the main chance, or even something else—but whatever the cause, the attitude of political parties to full employment is changing. The Tories hardly hide their feeling that a little unemployment is good for the country; say nothing as politicians but plenty as employers. The Socialists say very little but give the impression that a little unemployment would not harm their chances at the next election and might, in fact, precipitate one. Both parties have a repressed vested interest in a modicum of unemployment. Only the unions—who are going the right way to create it—cannot really want it.

The British worker does not mind changing his job—2½ million do so each year. He merely prefers to change from low to high, or from beastly to pleasant, as fancy and opportunity dictate. He certainly does not like moving his home and rarely does so—even in war time (he went in digs where directed). So factories should, as the Government have suggested for years, be put up where there is spare labour rather than houses put up round a factory where there is none. The British worker likes security, but this does not amount to a wish for permanence in a job (he would probably be appalled by such a prospect) but it does, apparently, mean adequate financial cover for any mishap.

HUMAN EYES CAN SEE MORE WITH TELEVISION

AND MORE EYES CAN WATCH

The developing techniques of television have brought to industry a new tool which has great potentialities. So far, these potentialities have not been widely realised. Industry in this country has not been quick to take up closed-circuit industrial television, though it is used on a large scale in America and is gaining rapid acceptance in Europe. What are the practical uses of television, other than public entertainment, and what technical developments are now taking place ?

The roles of industrial television (ITV is the colloquial abbreviation) in industrial, commercial, scientific and educational fields are divided into four principal categories:

(1) Where it would be impossible or dangerous to employ a human observer—inside furnaces, atomic piles, boilers, under water, close to high-tension electrical plant, observing the behaviour of aircraft in flight, etc.

(2) Where several observers would be required and can be replaced by an equal number of cameras bringing the image to a central point—for the co-ordination of processes or mechanical handling, for traffic and crowd control, for security purposes. In this case there is a saving of manpower and a more rapid reporting of events to a central controller.

(3) Where there is a need to demonstrate something to a larger number of people than can be accommodated in close proximity—for educational purposes in schools, hospitals, research establishments and the like.

(4) To see farther than is possible with the naked eye—for the detection of forest fires, observation of traffic in tunnels, seeing into ships' holds during loading and unloading operations, from an office desk to a records room, and a host of other such uses.

"BIG-BROTHER" APPLICATIONS

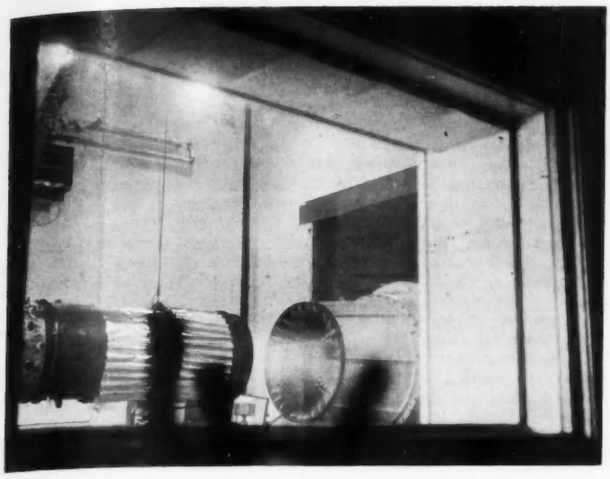
There are other applications which spring to mind but do not fall readily into these four categories. Among them is the viewing of microscope slides, which can be magnified on a television screen, or the testing of advertising displays and grouping prior to final showing on television, the pre-viewing of film scenes before they are photographed and, of course, the "Big Brother" function. Television is used extensively in the United States for property protection and security purposes; for example, to replace, or support, store detectives. British manufacturers of the equipment are unanimous in resisting this type of demand; obviously it is only a short step between watching for shop-lifters and watching staff, between watching for intruders in factories on secret work and watching over workers. The safeguard is simple enough: where a camera is located it should be clearly visible.

Closed-circuit television, as its name implies, is a means of transmitting a picture from a camera to a screen by means of a cable or a telecommunication system. An office can be linked to a records branch several miles away by a telephone line or a micro-wave link. A sales manager can be linked to every one of his area offices in the country. The first commercial installation in Britain—in 1952 by Pye Limited—was used experimentally to relay information between a banking firm's provincial premises and their London headquarters.

The set of equipment, or "chain," normally comprises one camera, one camera control unit and one receiving set. Ideally, the receiver should be a studio-type video-monitor (i.e., vision only), which should be cheaper to make than the standard domestic receiver though made to closer limits. In practice the large volume in which the latter are produced makes them cheaper. They are therefore quite extensively used, suitably housed in a steel cabinet. The price of the cheapest basic chain on the market is about £500, but the average expenditure incurred by buyers, including accessories and extras, is about £800 to £900.

The principal manufacturers of industrial television equipment in Britain are Pye Limited, Marconi's Wireless Telegraph Company, Limited, and E.M.I. Electronics, Limited. Together, these companies are selling chains at the rate of approximately 300 a year, including exports. Assuming that the average price of an installation is £900—it is likely to be somewhat less—the industry's turnover would be in the region of £270,000 a year. This is not large, particularly after three or four years have been spent on costly demonstration and market development work. Yet it could become a major outlet for

Smith Meters designer discussing a query with an experimental engineer by Pye television.



Marconi television camera (reflected in the mirror at the bottom of the picture) being used for observing after-burning in a gas-turbine engine.

British television equipment manufacturers. In the United States the annual sales in the past two or three years are said to have averaged between 15,000 and 20,000 chains. On the assumption that the British market averages one-tenth of the American, then sales in this country should be at the rate of 1,500 to 2,000 chains a year—at least five times their present level. It can be argued that the need for industrial television is even greater here, since factories are usually older, more cramped and therefore less easy to observe for the purposes of material handling and production control. In the United States the principal manufacturers are Thompson Products Inc., who make the Dage system; the Radio Corporation of America; Alan Dumont Laboratories; and the General Precision Equipment Company. The leading manufacturers on the Continent are Grundig of Fuerth/Bay., Germany, and Philips of Eindhoven, Holland, who between them supply the bulk of the market, the only effective competition being offered by Pye from this country. A number of British companies, other than Pye, Marconi and E.M.I., have at some time entered the market for industrial television but have dropped out for one reason or another. Peto Scott Electrical Instruments, Limited, and Central Rediffusion Services are two companies developing equipments, the latter for closed circuit studio use.

THE COST

There is little doubt that it is a field which small concerns are likely to find heavy going since the market development work—which involves detailed studies of manufacturing processes to find the best way to apply television—is very heavy and will remain so for some time. Perhaps one of the main drawbacks is that in their efforts to get the price down, some makers have tended to limit the effectiveness of the equipment; a number of companies who have had the equipment demonstrated have said that they found the image reproduction inadequate for their purposes. There has been some progress in this respect, but manufacturers have still some way to go before industrial television can reproduce an image as clearly as it can be seen by the naked eye. Manufacturers who have suffered from this handicap say they are rapidly overcoming it. Two of them, the Radio Corporation of America and Pye in this country, claim that their latest equipments operate on a horizontal picture resolution of up to 550 to 600 lines in the centre of the screen, which is 20 to 30 per cent. better than that obtained with a domestic television receiver operating on B.B.C. transmissions.

The differences between the various types of equipment manufactured in this country illustrate the difficulties the makers have had in assessing the market requirements. Pye sell a chain which they began to develop in the early 1950's and started to produce in commercial quantities about 18 months ago. The basic camera - control - unit - receiver chain sells for about £625, and the average price with accessories is some £900. Marconi developed their equipment from the basic "TV-Eye" design of the Radio Corporation of America, whose original intention was to make the cheapest possible set to sell to domestic users for watching nurseries, etc. The control unit, camera and monitor sell for about £500, but as the set is 525 or 625 line it cannot use the standard domestic receiver. E.M.I. Electronics, on the other hand, have so far marketed a more sophisticated chain which, like Pye's, operates all three standards—625, 525 and the domestic 405-line system. The more elaborate control unit incorporates a built-in motor and oscilloscope, electronic zoom control with automatic focus and remote control of camera lens filters. This unit sells for £1,200. E.M.I. are believed to have decided recently to develop a more competitively priced chain.

THREE DIMENSION AND COLOUR

The limitations of a flat black-and-white picture for certain applications have led manufacturers to carry out research and development into three-dimension and colour equipments. Pye showed a three-dimension set at the 1954 Radio Show. There are obvious advantages in three-dimension viewing where the remote handling of implements is involved, such as the removal of radioactive materials from an atomic pile with remotely controlled tongs. The main drawback is the expense, since stereoscopic applications require extensive alterations to basic cameras. Pick-up tubes, used in pairs in some equipment, cost between £70 and £135 each according to quality.

The introduction of colour television should considerably widen the range of industrial applications. The technical director of Pye, Mr. B. J. Edwards, outlined the work being done by his company in an address to the Radar Association last March. He placed special emphasis on teaching, which is an important use of black-and-white television, both in schools and in the medical world. Some of his remarks are incorporated in the brief description of industrial, commercial and scientific applications which follow.

An analysis of American applications shows that industrial uses are becoming increasingly important. The eight principal fields which have been developed and to which most of the sales are made are as follows, in order of importance :—

Property protection,
Remote observation,
Centralised record viewing and document verification,
Material handling,
Production control,
Work co-ordination,
Training and instruction,
General action monitoring.

In this country the situation is quite different, though beginning to change. Advertising displays in shops, the pre-viewing of television films and educational uses have, until recently, been prominent. Although the first-known commercial application was for centralised viewing of records, it has not caught on. The advantage to companies located in expensive overcrowded areas who would like to move records and clerical staff to outlying districts, using television to maintain a constant "live" link between the two, has not so far been realised though it will doubtless come about in time. So far, Glyn Mills, the bankers, have used television to link up their London office to their archives in the country, but no longer do so. I.C.I. use it for documentary transmission at Northwich, and Smith Meters Limited use a chain for a similar and other purposes at their Streatham works.

DANGEROUS PROCESSES

Watching dangerous processes is one of the main applications. The Atomic Energy Authority use Marconi and Pye equipment at Harwell, Sellafield and Didcot, and stereoscopic chains for the remote control of handling gear are on test at Harwell. A number of Pye chains are used to observe processes inside atomic piles. The Ministry of Supply's purchases have been substantial, but many of them are for defence applications and have not been publicised. Pye consider that colour television will play a big part in atomic power generation, e.g. for watching colour changes at different stages of nuclear reaction. This feature applies also to the manufacture of special glass where instant reference is required giving a colour index and a pencil-clear picture.

The aircraft industry is currently using a number of chains for a variety of purposes. The Bristol Aeroplane Company have two, one for watching icing conditions in flight to record the behaviour of certain test apparatus, and the other is on test in a helicopter for air-to-ground vision, a use in which the Forces and the Home Office are keenly interested. Vickers-Armstrongs use a chain for watching air flow over trailing and leading edges (indicated by woollen streamers). De Havilland and the Royal Aircraft Establishment also own chains, and colour television has been used to observe closely the combustion process in a jet engine where the intense heat and danger make close observation by engineers impossible.

Iron and steel manufacturers and engineering companies are beginning to make use of television for viewing certain processes, such as metal melting, pouring and re-heating, where human observation is either impossible or hazardous and where television serves as a useful check on indicating instruments. Babcock and Wilcox have installed chains to watch the operation of burners in boiler furnaces, and for telemetering water levels in boilers. Colvilles purchased a chain for watching the flow of slabs inside furnaces in order to ensure that the automatic sequence of operations is correctly co-ordinated—that the charging trolley is in line

Television channel equipment for industrial purposes. (E.M.I. Electronics Ltd.)

with the furnace rails on entry, that there is no jamming of slabs inside the furnace, etc. English Electric use television equipment in their Nelson Research Laboratories to demonstrate tests on high-voltage air-blast switchgear. British Timken Limited use a chain to enable the dispatch supervisor to watch the baling of finished bearings. These are only a few of the uses to which industrial television has been put in the metal industries. There are many other applications wherever it is important to watch a process which is hidden from view, or where co-ordination of different processes is required from a central point. The spread of automation, which is likely to necessitate such co-ordination and a centralised observation of manufacturing processes, should increase the scope as it has already done in the United States.

RESEARCH AND TEACHING USES

The chemical and process industries are beginning to use television though some companies say that available equipment is inadequate for their requirements, which pre-supposes that "tailor-made" equipment will have to be devised for particular applications. When this objection has been removed, as it doubtless will be within a short time (particularly with the introduction of stereoscopic and colour television and possibly higher resolution standards of 625 or even 1,000 lines), these industries should develop into important markets for the equipment.

Applications in scientific research and teaching establishments are numerous and growing. Teaching in schools, colleges and universities where one teacher could make himself available to large numbers of students may prove to be the largest field, particularly if colour is introduced at a moderate cost. Closed-circuit television is already being used at the Manchester College of Technology, the Great Ormond Street Hospital, the London College of Rubber Technology and elsewhere. Colour television could simplify the training of surgeons, by making it possible for them to witness every detail of an operation without having to crowd round the table. The use of the equipment as a means of magnifying and viewing microscope slides, to extend the performance of large optical instruments—such as electron telescopes in astronomy—and for observation of the sea-bed is likely to spread rapidly during the next five to ten years. Meantime, advertising, display and film testing will continue to provide a good market. The practice of hiring the equipment for demonstrations, sales promotion campaigns and the like is growing and seems assured of continued growth.

British manufacturers have worked so hard on the development of industrial television that it is surprising that potential users have not yet fully realised the possibilities. There seems to be a reluctance to spend money on the equipment, but its price is low compared to that of most items of machinery and plant if it is accepted as a worth-while tool of industry and education.

Letters to the Editor

"HI-JET"

Method of Metal Cutting

SIR, In the July 13 issue of ENGINEERING you refer to the Hi-Jet method of metal-cutting which has been the subject of laboratory investigation in the United States and this country for some time, and is now in production.

The final sentence of your paragraph on the subject is, I consider, misleading, and I would ask you kindly to assist in correcting any wrong impressions this may have made.

During the development of the Hi-Jet principle, it has been found that to get the best results the materials to be machined, the tools to be used, and the conditions of speed, feed, and cut, have to be studied, and the appropriate Hi-Jet fluid selected for those conditions. These fluids have been developed as the result of considerable experience in cutting a wide range of materials.

It is not simply a matter of taking an available type of cutting fluid, and applying it to the tool edge by means of a high-pressure jet. This has been tried by people who have either seen the system demonstrated in the United States or have read descriptions of it. Results in such cases have been disappointing. Tool life did not show the improvement expected, and in some cases, objectionable smoke and fumes were produced, which cannot be tolerated in a machine shop.

Gulf Oil have not only studied the question of appropriate cutting fluids, but have developed means of disposing of smoke, fumes, and spray, as part of the equipment.

Hi-Jet has been successfully applied to a wide range of materials including uranium, titanium, the Nimonics, and the toughest steels. It does not, however, show much advantage with free-cutting steels and soft materials, with which tool life does not usually present any problem.

As you state in your article, very considerable increase in tool life has been obtained when applying Hi-Jet to high-speed steel tools. This was with the appropriate cutting fluid. Similar increase in tool life can be expected when using carbide tools and a different fluid and appropriate conditions.

Due to the greatly increased tool life of high-speed steel tools, when used with Hi-Jet, it is probable that this type of tool can be substituted for carbide tools in some cases. Each case would naturally have to be studied individually by a specialist.

Yours faithfully,
J. RUSSELL KNOWLES,
Managing Director.

Gulf Oil (Great Britain), Limited,
London, S.W.1.
July 16, 1956.

★ ★ ★

BRITANNIA BRIDGE

SIR, In your issue of July 13, Mr. E. F. Clark asks for more information about Edwin Clark of the Britannia Bridge. There is no lack of published information. Stephenson appointed him superintendent of the bridge. He wrote *The Britannia and Conway Tubular Bridges* (two volumes and atlas, 1850), on the title page of which he called himself "Resident Engineer." He spells his name without the "e." William Fairbairn, however, in his *An Account of the Construction of the Britannia and Conway Tubular Bridges* (1849), mentions him often and spells his name with the "e."

The *Dictionary of National Biography* has a notice of him in the second supplementary volume under his younger brother's name—Latimer Clark. He was born in 1814 and died in 1894. After 1850 he seems to have been something of an inventor, taking out many patents in the hydraulic and electrical fields. He was awarded the Telford medal of the Institution of Civil Engineers in 1866. There is an obituary notice of him in *The Times* for October 26, 1894, and ENGINEERING of the same date.

Yours faithfully,
L. L. ARDERN,
Librarian.

College of Technology,
Manchester, 1.
July 19, 1956.

★ ★ ★

SIR, None of Mr. Stenson's out-of-the-way spellings need be taken for granted. When he writes "saime" for "same," "wirling" for "whirling," "Welch" for "Welsh" or "Markett" for "Market," for example, they may be attributed either to the hurry and exhilaration of spirits delightedly wrought-up by his marvellous experience, or to old usage.

It was his first meeting with Robert Stephenson's resident engineer. Quite probably, he had never seen his name in writing or print and would not, I fancy, have asked or checked its spelling. It is written "Clarke" each of the three times it occurs in the letter, that being, I suggest, the form to which Mr. Stenson was most accustomed.

If any of your readers could help to solve the more stubborn problem still tantalising me, I should be deeply grateful. The most important letters among his papers begin, "Dear John," or some similar form of address. He had but the one name, Joseph. No satisfactory explanation has yet been found despite wide search.

Yours faithfully,
N. DERMOTT HUNT (MRS.)

1A, Cambridge Park,
Bristol, 6.
July 18, 1956.

★ ★ ★

BOUNDARY LUBRICATION

SIR, I claim no special knowledge of lubrication or hydrodynamics, but feel bound to comment on Mr. L. E. Adams' letter in your issue of July 13.

His claim that his final result, equation (6), is new is open to challenge. Exactly the same equation appears in the notes I took as an undergraduate at University College London in 1953, and the working by which it was obtained was almost identical with that used by Mr. Adams. So far as I remember, it was not presented to us as original work, but I have no reference to the sources from which it was taken.

Yours faithfully,
F. PORGES.

34 Shirehall-park,
London, N.W.4.
July 15, 1956.

★ ★ ★

E. B. WEDMORE

SIR, Engineers will have read with regret the notice in your issue of June 29 of the passing of E. B. Wedmore. It is probably not generally known that in addition to his numerous activities in engineering, Mr. Wedmore wrote a most authoritative and comprehensive book on bee-keeping.

It is called *A Manual of Bee-keeping for English Speaking Bee-Keepers*, and is characteristic of its author in that the presentation is a model and an inspiration.

Yours faithfully,
H. E. ETHERINGTON.

Technical College,
Gravesend,
Kent.
July 5 1956

★ ★ ★

"TECHNOLOGY OF HEAT"

SIR, Your reviewer, in recognising the difficulties of teaching—which arise from the different interests as well as of the different abilities of those to be taught—seems to have confused the title of the book in question (ENGINEERING, July 6, page 17). The term "Technology of Heat" is *not* synonymous with that of "Thermodynamics."

It is obvious that there is much common ground between extreme points of view, much room for compromise, for bias and for differences of opinion. Some who acquire their first faith through "the application of heat to ironmongery" may later become disciples of Keenan, but certainly they are not all born to follow him from birth.

The book will, I hope, serve a useful purpose, as its predecessors have done, but it is *not* called "Thermodynamics."

Yours faithfully,
H. WRIGHT BAKER.

University of Manchester.
July 11, 1956.

Weekly Survey

Cover Picture: *After drawing molybdenum wire through a number of dies, a stage is reached when the tensile strength is such that further work upon it is not practicable and the material has to be annealed. This is carried out by passing an electric current through the wire in an atmosphere consisting of 75 per cent. nitrogen and 25 per cent. hydrogen. The presence of the mixed gas is necessary to prevent the oxidation of the metal. The wire is then ready for subsequent operations.*

★ ★ ★

The Treasury Divided

The announcement that the functions of the Treasury are to be formally divided into two and each of them is to be the responsibility of a Permanent Secretary of equal standing is an overdue reform of the first importance. Sir Norman Brook, while continuing as Secretary to the Cabinet, is to have charge of the administration of the Home Civil Service; while Sir Roger Makins will supervise those more well-known and, to-day, vitally important functions concerned with finance and economics.

The change has no doubt been considered necessary because of the increasing part of the Treasury's activities which are concerned not only with Government revenue and expenditure, but even more with the control of the overall economy of the country. Presumably the Prime Minister, in his capacity as First Lord of the Treasury, will now concern himself more with problems of the administration of the Government Service, while the Chancellor of the Exchequer will be left more free to concentrate on the exacting problems of economic planning. It is unfortunate that, under the first head, the Foreign Service is to remain a private empire and perhaps rather strange that one of its most powerful figures should now become the main administrator of our economic and industrial life.

Sir Roger Makins has, of course, had considerable experience of economic affairs at the Foreign Office and has no doubt had a good deal to do with them during his very successful ambassadorship in Washington. What remains to be seen is whether he will be able to bring to his new task the knowledge, the drive and the breadth of vision which it requires. The problems of the control of finance and of industry are to-day inextricably interwoven and recently the Treasury has come under considerable fire both for its failure to react quickly enough to the indications of change in the national economic weather and for its lack of understanding of the workings of modern industry. This is not the time for a further injection of that amateurism so beloved of the British governmental system; but of a strengthening of those professional techniques, sometimes more successfully employed on the other side of the Atlantic, by which our economy can be kept on a stable course in a changing world. It is by the success with which this latter task is carried out that the new changes will be judged.

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Economic United States of Europe?

European countries are moving even closer together in their stuggle for economic strength. First there was the Steel and Coal Community, then Euratom, and now a proposal to reduce the time schedule before quota and tariff restrictions on trade are swept aside. At last week's meeting of the Council of the Organisation for European Economic Co-operation, British ministers left no room for doubt as to their Government's wish to be in on the projects that were discussed. Equally, Mr. Macmillan made quite clear to his German opposite number, Dr. Erhart, and to the 30 other European ministers taking part that Britain had her Commonwealth and other Sterling area ties to consider. Incredible as this may seem, the questions on the agenda do not appear to have been carefully discussed, if at all, at the Commonwealth conference which immediately preceded the O.E.E.C. meeting. The importance attached to the proceedings and the concerted action that will follow were underlined by Sir Edward Boyle in the House: no other single matter is likely to engage the Government's attention more fully in the coming months.

The most spectacular result of the conference was the decision to set up a working party to study what is involved in establishing a common market in Western Europe, and to evolve a practical scheme to create a free-trade area within the six countries—France, Germany, Italy, Belgium, the Netherlands and Luxembourg—who have made most progress in this direction so far, " and other O.E.E.C. members." Meanwhile, the present target of freeing 90 per cent. of private imports will be continued until the end of 1957. Tariff reductions are to go on as rapidly as possible, but Mr. Thorneycroft explained that the British Government could not accept a proposal that by next July a low tariff system should be worked out, based on a list of European products on which the tariff would be reduced. This would have meant that, under the most favoured nation clause, Britain would have had to pass on these concessions to countries outside Europe. This is the major policy decision now facing this country—whether a better opportunity to trade with Europe is worth sacrificing a position of advantage in the Commonwealth. But to be left out of a common market in Europe may prove to be even more damaging. Moreover, Britain's trade strength is badly needed there to restore a balance, as Germany is developing into a very big creditor nation and thus threatening the whole conception of a common market.

The British representatives have strongly suggested that the Government will now come much closer to Western Europe than hitherto. The abolition of the import duty on pulp and paper is proof of the importance they attach to the economic objectives of O.E.E.C. Unless something is done quite quickly, Western Europe might well become a German economic dependency.

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Transmission Invasion

Last week the American penetration of the British motor industry took a significant step forward with the opening of the Borg-Warner transmission factory at Letchworth, planned to build 500 automatic transmissions and 250 automatic overdrives per day. This £4 million plant has been built in 13 months and equipped with 500 machine tools, most of which have been shipped from the United States where they have already seen considerable service and were presumably largely written off. The automatic transmission they are to make is one that has already been discarded by American car manufacturers. The Americans have thus been able to bring into production an automatic transmission for British and European cars far earlier than a British manufacturer could have hoped to do, and the mere existence of this big modern plant, backed by enormous dollar resources, will be a powerful deterrent to any potential British competitor, who would have to lay out millions of pounds, and face all the difficulties which surround capital expenditure at the present time, in order to put a rival transmission into production.

In the overdrive field, the battle is only just beginning. The American overdrive has several disadvantages as compared with the established British type. It can only be brought into action on a light throttle, with the aid of an ignition cut-out, so full-torque upward changes are impossible. A momentary check in heavy traffic may bring it into action unintentionally. The car free-wheels in direct drive, unless the overdrive is put out of action, which can only be done at rest or in direct drive under load. However, the circumstances of its manufacture will presumably make its price highly competitive, which may be one reason why the B.M.C. which has most to lose from American penetration of the British industry, has adopted the American overdrive in preference to the British one, for most of its range.

Meanwhile, in this country, Laycock Engineering have just brought additional productive capacity into use in Sheffield, and have started work on another large factory near their main works at Millhouse. This will bring production capacity for the British Laycock de Normanville overdrive up to 700 units per day.

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Caution for Steam Power Plant

There is a fairly widespread feeling in the steam power plant industry that the hey-days of the post-war period are over. This is not because the demand for power is expected to fall, or the demand for process steam. On the contrary, increases at near the present rate are envisaged. The reasons are two-fold: increased competition overseas and technological change.

Competition has come mainly from the growth of German capacity which, added to the rest, has made supply at last catch up with demand. Technological change is in two main directions so far: atomic energy and water power. There has been, in the past few years, a considerable effort in many parts of the world to develop hydraulic sources of power. The world shortage of fuel made this inevitable, but there are now proportionately less boilers and other steam plant required for new capacity than was the case 30 years ago, or even in the 1940's. The development of atomic energy makes as yet very little impact upon the demand for steam raising plant, but that it will do so in five years no-one seriously doubts. In 20 years time there may be no new " traditional " thermal power stations going up in any part of the world. This is not the type of product which lends itself to gradual adoption; when something more economic has been found the annual economies generally outweigh the annual cost of investing in new plant and the change-over may be rapid.

Mr. Edward W. Thompson told his shareholders last week that his company, John Thompson, Limited, had considerably increased their expenditure on research, since " we feel we are compelled to keep in the forefront of new developments." His review contained a detailed account of the company's activities in the field of atomics. A new company, John Thompson Nuclear Energy Company, Limited, has been formed, and the link with the A.E.I. group to enable the two concerns " to tender as an entity for complete atomic energy power stations " has already proved beneficial to both. But Mr. Thompson found it difficult " to see into the future with any precision." The atomic energy future is still largely controlled by the politics of nations—and by the availability of enriched fuels. Progress may be slower than anticipated, or it may be faster.

It is a difficult situation to handle for a large maker of traditional steam-raising plant. Yet John Thompson have an order book of £35 million (output of £23·2 million in 1955) which is only slightly less than a year ago. In this, as in many other heavy engineering industries, the need is for vigorous and determined selling overseas—and for the addition of new products to a range that may have become seriously depleted in ten years' time.

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India's Road to Industrialisation

Five-year plans are generally received with some scepticism by those in the older industrial countries. India's plan has been no exception. That it is soundly based and will undoubtedly be carried out is, however, the conclusion of Mr. Stephen Garvin, who has just undertaken a survey for the Federation of British Industries. Mr. Garvin was a member of the Indian Civil Service and his generous and valuable report on the political and economic background to India's industrial development is required reading

for industrialists thinking of entering the growing Indian market.

He sees Indian Socialism as a pragmatic form of mixed economy made necessary by the urgency of the industrial task, the absence of large-scale private enterprise and the past activities of a Government which originated in a commercial monopoly.

Indians are proving themselves very capable administrators, but in the immediate future they will need considerable assistance from foreign technicians, and recent changes in income tax laws may act as a deterrent to those who would otherwise be willing to work there. On the other hand Mr. Garvin does not consider that the very considerable control exerted by the Indian Government over private investment should deter foreign investors who wish to establish industries of the types not within the field of state enterprise. The latter include all basic industries, heavy machinery, mining and mineral processing, rail and air transport, shipbuilding, electricity generation and distribution and telecommunications. A number of other industries such as chemicals, machine tools and road and sea transport are to be mainly state-owned with private enterprise participation, but this still leaves considerable scope for private enterprise which will receive full encouragement if it is likely to contribute to India's progress.

The scale of the effort being made can be measured by the fact that, whereas in the last five years the national income has risen 18 per cent., it is intended to raise it 25 per cent. in the next five. This will still leave India a very poor country and the market for consumer goods will not be large, especially as it is the intention to restrict the import of these goods and increasingly to make them in India. The same will apply to a growing range of capital goods, and intending British exporters should examine carefully both the " Red Book " *Indian Import Control Policy*, published twice a year and the figures for expansion of separate industries in the five-year plan, before undertaking a market-research and sales campaign for their own products.

British investment at £300 million still remains 80 per cent. of all foreign investment in India, but increasing interest is being shown by the U.S.A., Germany and Japan as well as the iron curtain countries. There remains, however, immense good will towards Britain, which takes one-third of all India's exports and sends her one quarter of her imports. The substantial and rapid industrialisation now taking place, under whatever conditions, offers great opportunities for expanding this trade provided there is constantly renewed initiative and enterprise on the part of British firms. Whether there can be a similar increase in British investment depends on our achieving a reasonable surplus in our balance of payments; but the importance of our doing so in face of totalitarian competition is obvious. Most Indians want to achieve her industrialisation by democratic means; but if these were to fail Communism could be made to seem an attractive proposition to many of them.

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Crucibles and Carbon

A 100 years ago in 1856, five Morgan brothers purchased the manufacturing rights for an American crucible and also bought a small factory at Battersea. Today the Morgan Crucible Company is a world-wide organisation making carbon and ceramic products ranging from brushes for electrical machinery and sliding contacts for trolleybuses to equipment for atomic energy installations.

Though the company continues to manufacture crucibles and refractories, carbon has been the centre of many other activities, and it is this concentration on a single field that has proved so rewarding. Originally Ceylon was the company's sole source of graphite, a mineral species of carbon, but at the turn of the century *anzamanga*, a Malagasy word meaning " plenty black stuff," was discovered in Madagascar, where it is quarried—not mined—to this day. Perhaps, in view of the sooty character of the firm's principle product, there was a touch of irony in the decision to film part of " The Man in the White Suit " at Morgan's. But the company's contribution was more than a location, since arc electrodes for cinema projectors are an important use of carbon.

To celebrate their centenary, the Morgan Crucible Company have published an elegant volume outlining the firm's history from the first plumbago crucible to the intricate items for electronic equipment made to-day. It is a history that reveals how a material apparently limited in scope and application can achieve a wide and varied usefulness through research and perseverence.

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Australia's Automobile Ambitions

While the British motor industry struggles with the problems of redundancy and short time precipitated by restrictions in the important Australian and New Zealand markets, a new £1 million agreement opens the way for larger exports of cars and trucks from Australia to New Zealand. Last week, General Motors revealed the new model of the Australian-built Holden car which will spearhead the new Australian export drive. It is a full six-seater, on a longer wheelbase and wider track than the old one. Basic design of the 6 cylinder o.h.v. 2,171 c.c. engine is unchanged, but power is raised to 70 b.h.p. by larger valves, improved inlet passages, and a higher compression ratio. Suspension is improved by the addition of an anti-roll bar at the front, and re-circulating ball steering is used. The electrical system is changed from 6 to 12 volts, and the clutch is now hydraulically operated.

Although the body is of typical modern style, the ground clearance necessary for undeveloped areas has been maintained, the lowest point being the differential casing, $7\frac{5}{16}$ in. from the ground. A remarkable feature of the previous model, although designed for some of the roughest motoring conditions in the world, was its dry weight of one ton. Despite the bigger body, larger battery and extra equipment, the new one maintains the tradition with a " kerb " weight of 2,380 lb. Prices with taxes come between £910 and £960 sterling, an increase of about £36 over the old ones.

British manufacturers, notably B.M.C., Standard and Rootes, are investing large sums in local manufacturing facilities. B.M.C. in particular hope before long to be building an all-Australian car, which should enable them to participate in the development of Australia's vehicle export trade. But the Americans are well established. In 1955, Holden sold 62,459 units on the Australian market, and exported 1,341. They had almost 27 per cent. of all new passenger car registrations, and 32 per cent. of light utility trucks. Planned production of Holdens for 1956 is 69,000. They hope that the current £16½ million expansion programme will bring output to 100,000 per annum by 1958. Dividends paid in 1955, totalled nearly £4 million, and although all payments remitted to the United States are subject to a 15 per cent. tax in addition to normal company profits taxation, the size of these payments has begun to cause criticism in Australia.

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More Work in Oil Refineries

Last week the Esso Petroleum Company published details of their programme for a further expansion of the Fawley refinery. It will involve a capital expenditure of £13 million, in addition to the £9 million scheme announced in April to supply raw materials for the manufacture of synthetic rubber and other chemical products. The total investment in Fawley refinery will then amount to £68 million, and when the expansion is completed at the end of 1958 throughput will be raised from 7½ million tons to 10½ million tons per annum.

Taking into account the plans of the British Petroleum Company to expand the Isle of Grain refinery and the proposal of the California Texas Corporation and the Trinidad Oil Company to erect a new refinery for their subsidiary the Regent Oil Company, this brings the total of additional refinery capacity announced during the last six months to over 10 million tons per annum, a figure which compares with total capacity for all Uunited Kingdom refineries at the beginning of 1956 of about 29 million tons. In addition it was announced at the beginning of July that the California Texas Corporation, the Esso Petroleum and Shell-Mex and B.P. are to erect a refinery in Eire, which will cost £12 million and produce 1½ million tons of finished products per annum.

The Esso Fawley proposals provide for the installation of a third pipe still with a capacity of 9,600 tons per day, two new auto-Diesel hydrofiners, a second sulphur recovery plant which will double the refinery's current output of 13,000 tons of sulphur per annum, and a new oil and water separator plant, together with additional berths and tankage for the storage of crude oil and finished products.

The expansion of British refinery capacity may be expected to continue over the next five years, if forward estimates regarding the probable demand for petroleum products are realised, and it should provide a considerable

100,000 Holdens per annum by 1958 (see " Australia's Automobile Ambitions").

market for British engineering industry. In announcing their new plans, Esso estimate that over 90 per cent. of all materials used in the new construction will be of British origin. During the initial expansion programme between 1949 and 1951 the corresponding figure was only 66 per cent. Well over 4,000 men will be employed on construction.

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Change Partners in Chemicals

As at a dance, it is a good thing in business to change partners occasionally. I.C.I. partnered du Ponts for a long time to the great benefit of both. I.C.I., for example, developed Terylene which, as Dacron, became a well-known textile in the U.S. long before Terylene was known over here. It is the anti-trust laws which have brought about the recent pairing of I.C.I. and the Hercules Powder Company, du Ponts' main rivals in explosives. The immediate result is a substantial I.C.I. investment in an 11 million dol. Perspex plant in Missouri. Hitherto—mainly because of the du Pont agreement—I.C.I. have not had any major enterprises in the U.S. comparable with those of other British giants such as Levers, Courtaulds and Bowaters, though they bought a small Rhode Island dyestuffs company called Arnold Hoffman and Company, in 1950. I.C.I. also entered into a partnership agreement with the Columbia-Southern Chemical Corporation to build a titanium-sponge plant in West Virginia.

I.C.I.'s expansion into plastics in the U.S. has recently had its counterpart in the plans made by Union Carbide (the third largest chemical group in the world, du Ponts being the biggest and I.C.I. second) to build a polythene plant at Grangemouth, getting ethylene for the purpose from British Petroleum Chemicals (Distillers/British Petroleum). It will sell through Bakelite Limited, its British subsidiary. Hercules Powder are also in the polythene business in the U.S., where they use the (German) low-pressure Zeigler process at Parlin N.J. under licence from Farbwerke Hoechst. Sales of all the acrylics put together in the U.S. are not over half those of polythene and the latter is still expanding at a fabulous rate—a recent paper to the Manchester Association of Engineers estimated world output in 1965 at 1½ million tons a year. But Hercules Powder's market research facilities are good enough to give every assurance that Britain will draw a useful dollar income from I.C.I.'s new investment.

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Paper-Making Machinery Outlook

The giants in the paper-making industry have expressed their views in the last few weeks about the outlook for paper. Some have expressed concern about rising costs. Not all of them are confident that 1956 will prove to have been as good a year as 1955. There has been some evidence that paper makers have been hit by the credit squeeze, and that trading has been difficult in paper converting and in paper bags. The price of paper bags, according to the Board of Trade price index number of commodities, declined from 127·9 to 121·2 between March and April, 1956 (June 30, 1949, being equal to 100) and has stayed there until the end of the calendar half year.

It is difficult to see in this situation more than a passing phase. The long-term trend of paper consumption in a world which is, as a whole, still starved of the printed word must surely be upwards and the recent prosperity of paper machinery makers should not be seriously jeopardised by short-term difficult trading conditions. Demand for more machines and for more elaborate machines (the last now being able to justify themselves on increasing runs at paper mills) should continue. It has been estimated that between now and 1960, 700,000 tons of new paper capacity should be added to the U.K. industry, including about 300,000 tons of newsprint capacity. An increase of 400,000 tons of paper and board represents an advance of about 15 per cent. over the 1955 figure. Until comparatively recently, capital expenditure by the paper companies had been mostly for restoring capacity lost during the war. Real expansion has only just begun. The announcement last week by the Board of Trade that import controls on paper, board and paper-making materials (excluding newsprint and certain other types of paper) have been removed from July 22, 1956, may have coincided with rather more difficult trading conditions. In the long run, however, they will make their contribution to expanding production in the paper industry.

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Selling Technical Knowledge

A recent case in the courts on the sale of technical knowledge is of wide interest to industry. The case was Evans Medical Supplies Limited *v.* Moriarty, and concerned an agreement by which the company had sold certain secret processes and technical data on pharmaceuticals to the Government of Burma. For this sale, the company had received what it called a "capital sum" of £100,000. The Inland Revenue had attempted, however, to treat this deal as a receipt of income, which would therefore be liable for taxation as a trading profit. Their view was upheld by the Special Commissioners, who held that the sale of such processes by a company under such conditions was not the disposal of a capital asset but a method of carrying on its business.

The company appealed to the Court and the ruling of the Special Commissioners has been reversed. The upshot of the Court's opinion is that a principle has been established for the assessment for taxation purposes of receipts from the sale of technical knowledge. The gist of this principle seems to be that a single transaction of this kind will be deemed to be the sale of a capital asset. If more than one is made, however, it may be possible for the Inland Revenue to argue that this kind of business is a normal trading activity of a company and receipts from it will be liable to tax.

Presumably this case could have gone to the Court of Appeal, but meanwhile the judgment stands. There is no doubt that although it has been argued in terms of chemical compounds, the principle has considerable significance over a wide range of engineering expertise.

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More Telephones

The American Telephone and Telegraph Company are planning to raise a further 575 million dols. of new capital with a view to meeting a capital expenditure this year of 2,000 million dols. This compares with an expenditure in 1955 of 1,640 million dols., and it is expected that capital requirements in 1957 will be at least as large as those in 1956.

In Britain, the Telecommunications, Engineering and Manufacturing Association have issued their annual report for 1955-56. It shows that in this country the total capital expenditure of the Post Office for 1956-57 on the telephone, telegraph and postal services is estimated at £77·5 million. Although this represents an increase of nearly 10 per cent. on the estimated figure for 1955-56, the disparity in the rate of development between the two countries is very marked, even allowing for differences in population and geography. And since the figures for 1956-57 were published, it has been stated that the Post Office estimates are to be cut by about £5¼ million.

The latest figures for the number of telephones installed in this country are those contained in the Post Office Commercial Accounts for 1954-55. In that year 353,000 additional telephones were connected to the public system. Although this represents a considerable advance on the figure of 268,000 for the previous year, practically no impression was made on the number of applicants outstanding at the end of the year, which amounted to 372,000 compared with 376,000 at the end of the previous year.

With 12·74 telephones per 100 population the United Kingdom ranked ninth in telephone density and also occupied a similar position as regards rate of increase in the number of telephones installed (based on figures for January 1, 1955). Details of the proposed cut in the Post Office estimates have not been announced, but it has been stated that the greater part of these cuts will involve the long-term provision of trunk lines. It is possible that the postponement of a second television programme for the B.B.C. and the I.T.A. may account for a fair proportion. It is certainly to be hoped that there will be no major cuts in long-term provision of trunk lines and new exchanges. Such cuts would seriously restrict connection of new subscribers in two or three years time when it may be hoped that financial conditions will permit an increased rate of development.

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"Substantial Order Book"

These words were taken from the chairman's annual review at the annual general meeting last week of Charles Churchill & Co. Mr. J. B. S. Gabriel summed up in a few words the present troubles of the machine-tool industry: "the new year was started with a substantial order book" and "costs have been increasing steadily in every direction." The British industry is having to quote very extended deliveries and, in many cases, prices which do not compete much more effectively than do the delivery quotations in overseas markets.

The outlook for the machine tool industry is indeed a very fair one. Rising labour costs are forcing many companies to re-equip with machines more economical of labour; the introduction of new production techniques—particularly electronic controls and automatic in-line transfer—mean that when one company has re-equipped it is in a dominant position within its industry. The complaint of rising costs by Mr. Gabriel is justified for the engineering and metal industries generally. But for the machine tool industry it must mean a high level of prosperity for many years to come, provided the industry is able and willing to keep itself up to date, not only in ideas but also in manufacturing techniques and plant. Perhaps more could be done to offset the increase in manufacturing costs by greater efficiency than Mr. Gabriel suggests, despite the fact that "machine tools vary considerably in design, range and equipment, and are largely built by skilled labour."

The future economic strength of this country is closely affected by the adequacy or otherwise of the machine tool industry. There is at present a great deal of diversity, some of which might be avoided; a heavy dependence on imports which need not perhaps be maintained for as long as it has been; an apparent lack of determination in selling overseas—with a few notable exceptions—which cannot help the industry to get the necessary volume of output to overcome problems of rising costs.

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The Society of Chemical Industry

The principal task of the Society of Chemical Industry is to arrange scientific meetings and to publish journals; it is not subsidised by the chemical industry and the interests of the Society extend far beyond the chemical industry itself and embrace all industrial applications of chemistry. Since its foundation in London in 1881, ten special groups have been formed and these groups, in the order of their establishment, are concerned with chemical engineering, food, road and building materials, plastics (and high polymers), fine chemicals, agriculture, corrosion, microbiology, oils and fats, and pesticides.

This year's annual meeting, held from July 9 to 14, has been given special emphasis to mark the Society's 75th anniversary. Nine lectures were delivered during the meeting, on the theme "Achievements of Industrial Chemistry," and the speakers reviewed the advances made during

the last 25 years, i.e., since the jubilee of the Society in 1931, in the application of science to chemical plant, processes and products.

After an introductory lecture on "Modern Methods of Research" by Dr. L. A. Jordan, there were two parallel series, each of four lectures, one on the new products of industrial chemistry, including plastics, artificial fibres and antibiotics, while the other series surveyed the tools of industrial chemistry including the use of metals and non-metals in plant construction as well as new manufacturing techniques and modern methods of recording and analysing the results of factory operations.

The meeting was attended by nearly 1,000 members and guests, and on July 10 delegates from 39 learned societies in Great Britain and overseas presented scrolls containing congratulatory addresses to mark the Society's 75th anniversary.

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Metal Cans

Metal cans continue to meet growing competition from other types of container in the United States. In a recent issue of ENGINEERING (May 25, page 391) comment was made on the decision of the American Can Company to develop "margin" plating for its cans. In this process, only the margins of the steel strip, which subsequently form the soldered side seams, are tinned. A cheaper surface coating is applied to the remainder. There are now further signs that this company is anxious to reduce the cost of metal cans to make them more competitive with other forms of container.

In an effort to reduce production costs, the American Can Company intend to spend 27 million dollars over the next two years on a re-equipment programme. Instead of buying fully processed steel from outside, they propose to buy steel in large coils and carry out their own inspection, chemical treatment and cutting into sheets. The main project is a new tin-plate processing plant employing 500 operatives in Chicago, and another new plant is contemplated for New Jersey.

The company are in fact caught between the rising cost of tin cans and the increasing competitive power of other types of containers. In the last 10 years the company's production costs have gone up by 91 per cent., while the price of its cans has increased by only 75 per cent.

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John Saxby

In June, 1856, a United Kingdom patent was granted for an apparatus for working the points and signals at an ordinary double line junction by a form of simultaneous motion mechanism which ensured that they could never be in dangerous disagreement with each other. The patentee was John Saxby, then a man of 35 and employed in a responsible position in the locomotive and carriage works of the London Brighton and South Coast Railway at Brighton, under J. C. Craven, predecessor of the well-known William Stroudley. This patent has generally been regarded as marking the beginning of signal and point interlocking in Great Britain and it came only a year after Vignier in France had made mechanism answering the same purpose but without taking a patent for it. The two men knew nothing of each other's endeavours for some time, but eventually Saxby became as well known in France as Vignier and the factory established there by Saxby in 1878 is active to-day and still bears his name.

The form of construction of the 1856 apparatus however did not constitute interlocking as finally understood and still understood to-day. The principle of this was seen in apparatus made by Austin Chambers in 1859, and adopted by Saxby the following year. Some years passed before it came into extensive use. The larger terminal stations, such as those in London, were fitted with interlocking during the '60s, several of them by the firm established by Saxby in association with J. S. Farmer, who was for some time the assistant traffic manager of the Brighton Line. Other firms were also active in supplying apparatus of their own designs. Saxby left the firm in 1888 and devoted himself entirely until 1900, when he was 79, to directing the factory in France. He lived for another 13 years and passed away, nearly 92, in his native Sussex and was buried at Wivelsfield, alongside the line on which his first work was done and to which his firm enjoyed the exclusive right of supplying signal apparatus until as late as 1904.

Saxby's name became especially well known through his invention of a particular form of actuation of interlocking from the lever catch handle and a type of locking frame expressly adapted to use it. He was also the patentee of the plunger type of facing point lock, so universally used in English speaking countries, while his partner Farmer and their close associate Charles Hodgson also patented items of signalling equipment which achieved considerable success. For the most part they left the development of electrical apparatus, which for some time in any case was confined to such equipment as the block telegraph and signal and point repeating devices, to others, and we do not find Saxby himself associated with what came to be called power signalling.

Changing conditions towards the close of last century led to a fusion of interests among signal manufacturers and the disappearance of some undertakings. The business of Saxby and Farmer eventually became absorbed in that of the present Westinghouse Brake and Signal Company, which has issued an interesting illustrated publication commemorating the work of Saxby and his associates. The application of scientific knowledge to signalling has effected changes going beyond any that Saxby could have imagined, but the objective sought to be attained thereby is still the same as that with which he was concerned the securing of the highest possible level of safety combined with maximum flexibility of traffic operation consistent with a reasonable outlay for both first cost and maintenance. The highly developed equipment of to-day is but another manifestation of the thought which inspired the production of the equipment for which John Saxby asked for patent protection a century ago.

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Unskilful and Unsafe

In recent issues of ENGINEERING correspondents discussed the subject of skilful driving as it bears on road safety, and, in particular, reference was made to Dr. J. S. Blair's valuable book *The Skilful Driver*. In the correspondence columns of the *Financial Times* recently, Mr. John Murphy attacked old crocks which "are a menace to public safety and cause no end of traffic jams by limping along in a semi-comatose state."

Bad driving and old unroadworthy vehicles doubtless play their part in the frightful road casualties, worse each month. The Ministry of Transport's statistics for April and May show a steadily rising toll of lives. In May, 458 people were killed in Great Britain and 5,584 seriously injured, increases of 41 and 281 respectively on the figures for May, 1955. In the first five months of the year there were 9 per cent. more accidents than in the corresponding period last year. Deaths number 2,001—an annual rate of nearly 5,000—and serious injuries 22,601.

This worsening situation is so grave that it would surely justify some degree of interference with the rights of the individual motorist. Why not a vehicle test for road worthiness obligatory at the owners' expense at any time during each year of the vehicle's life exceeding five years? Why not more supervision of drunkenness, with long periods of disqualification for the guilty? There is much that could be done to minimise the accident rate in these two directions alone. In others, proficiency badges, educational films, and in general more financial support for the road safety organisations would help further. We can hardly wait for the better roads we might get in ten years' time.

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The Late Sir Henry Guy

Sir Henry Guy, who died on July 20, was secretary of the Institution of Mechanical Engineers from March, 1942, to January, 1951. It was characteristic of him that during that period he combined with his duties as secretary, membership of numerous Government and other committees which brought him into contact with leaders in science, engineering and politics. It was during that period, too, that the membership of the Institution was doubled and the amalgamation with the Institution of Automobile Engineers took place. He was elected a Fellow of the Royal Society in 1936 and was Knighted on the occasion of the New Year Honours List of 1949.

Henry Lewis Guy was born on June 15, 1887, and received his later education at Cardiff University College and Manchester College of Technology. He served a pupilage on the Taff Vale Railway and in 1910 joined the staff of the British Westinghouse Company, with whose successors, the Metropolitan-Vickers Electrical Company, he remained until 1941. He became chief engineer in 1921 and was made a director of the Metropolitan-Vickers Electrical Export Company in 1936. His work in industry was concerned mainly with the development of steam power plant.

Of his service on committees and councils the *Journal of the Institution of Mechanical Engineers* contains several records. Among his principal activities of this kind were membership of the council of the Royal Society; chairman of the Engineering Sciences Sectional Committee of the Royal Society; member of the Executive Committee of the National Physical Laboratory; chairman of the Engineering Research Committee of the N.P.L.; chairman of the committee of the British Electrical and Allied Industries Research Association; member of various British Standards Institution committees; member of the Advisory Council of Scientific Research and Development of the Ministry of Supply; chairman of its Gun Design Committee; chairman of the Committee on Armament Development; chairman of a committee to report on the Royal Aircraft Establishment; chairman of a committee to report on the organisation of aircraft armament research and development; chairman of a committee on the technical organisation of the Army; chairman and member of various post-war committees of the Ministry of Supply's Scientific Advisory Council; member of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research; chairman of the D.S.I.R. committee on "The essential requirements for research in mechanical engineering"; chairman of the Mechanical Engineering Research Board of the D.S.I.R.; member of the Fuel Research Board of the D.S.I.R.; member of the Scientific Grants Committee of the D.S.I.R.; member of a committee to report on research in British Railways; and a trustee of the Imperial War Museum.

Sir Henry joined the Institution of Mechanical Engineers as a graduate in 1906; he became an associate member in 1912 and a member in 1927. He first took a direct part in Institution affairs as a member of the North Western Branch Committee in 1926, and he became chairman of that branch in 1929, in which year he also became a member of Council. In 1938 he was elected a vice-president, but in 1941 he resigned both his vice-presidency of the Institution and his appointments with the Metropolitan-Vickers companies.

At a general meeting of the Institution on October 24, 1941, he was appointed secretary, but he did not take up his appointment until March of the following year. His retirement, on the grounds of ill-health, was announced in September, 1950, and took effect on January 19, 1951. The Council elected him an honorary member of the Institution at their meeting on December 14, 1951.

RAILWAYS IN TROPICAL AFRICA

SOME PROBLEMS OF SURVEY AND CONSTRUCTION

Two informative papers dealing respectively with railway construction in East and West Africa were read at the recent "Conference on Civil Engineering Problems in the Colonies" convened by the Institution of Civil Engineers. One dealt with work in Kenya, Uganda and Tanganyika and the other with the Gold Coast and Sierra Leone. All these territories lie on, or within a few degrees of the equator, but the climatic conditions of east and west are by no means similar. This naturally had much influence on survey procedure and construction methods. The East African railways, dealt with by Mr. J. McFarlane Kesson, now form an extensive system. The original lines in Uganda were built by the British and those in Tanganyika by the Germans between 1896 and 1914. Interconnections and extensions have since been carried out and are still in progress. The West African railways, dealt with by Mr. E. S. George de la Motte, in general run inland from the coastal ports; there is some interconnection. Mr. de la Motte described the methods followed in recent developments.

The importance of railways construction in the industrial and social progress of colonial territories of the type dealt with in these papers requires no emphasis. In the present urge for betterment and a higher standard of living, which is evident almost throughout the world, the contribution to social amenity and trade development, which railways can make, has attained a new importance. The decision to proceed with new works, and the provision of funds, are matters for political decision, but the problems of actual construction have to be dealt with by professional engineers. It is this aspect of the matter which is dealt with in these papers. They are not concerned with the broad general question of the impact of new railways on the political, social and economic progress of relatively undeveloped countries; they are concerned with the technical problems which political decisions to proceed with new construction have raised.

AERIAL SURVEY INSUFFICIENT

Some of the difficulties which have to be faced were dealt with by Mr. de la Motte. He was particularly concerned with the construction of a 50 mile railway link between Achiasi and Kotoku in the Gold Coast, the purpose of which was to shorten the railway route between the port of Takoradi and Accra, the capital. About half the country traversed was covered by thick forest and particularly in connection with areas of that type the paper provided interesting information. It has been found that vertical air photographs of a belt about 4 miles wide over the general line of the route are of assistance in determining the location, but full photogrammetric mapping is impossible. The ground is invisible and the forest canopy lacks uniformity. It is suggested that a radar-sounding device, giving a radio echo from the ground might provide a longitudinal profile, but procedure based on such an instrument is yet only in the experimental stage.

For reconnaisance work in the forest, the procedure followed is to cut traces on magnetic bearings, using a prismatic compass, along lines determined from a map and confirmed, or modified, by air photographs. Levels are taken by aneroid, but this procedure does not provide readings closer than within 15 ft. Deforestation of the right of way is carried out in two stages. The first covering the clearing of bushes and trees up to 1 ft. in diameter; the second, the felling and removal of larger trees. The first stage was carried out by local African labour at a cost of £240 per mile. For the second stage, it was hoped to pull out large trees, with the root system, by a cable attached to a winch. Many cables were broken, however, and finally the trees were felled and the stumps removed by bulldozer.

The sleepers used were of pressure-creosoted local timbers; the Railway Administration had laid in large stocks. It is hoped to obtain a life of 15 years from these treated sleepers, compared with an estimate of 40 years for steel. Untreated local-timber sleepers had been used during the war and had lasted only 5 years. The estimated long life for steel sleepers would appear to be confirmed by experience in East Africa. In his paper, Mr. Kesson records that German steel sleepers installed on the Tanganyika railways have had a life of more than 50 years. A similar life has been obtained in Uganda under light traffic in non-corrosive soil; under heavier traffic the life is about 30 years. Steel sleepers have been mainly used on these East African railways as local timbers have failed to give an economic life.

A local condition calling for special arrangements in East Africa is the low, or moderate, rainfall. This has involved special arrangements in connection with water supply. Boreholes have been sunk where possible, but yields have not been plentiful, and over many hundreds of miles in Tanganyika boring has been entirely unsuccessful. For most major water supplies, long pipelines have had to be laid. There are three major installations of this kind, one 90 miles long, another 40 and a third 60 miles. Gravity flow is arranged for where possible but some pumping is necessary.

* * *

OIL HEATING INSTALLATION

A Contribution to Smoke Abatement

At the Dingle Bank Petroleum Installation, near Liverpool, Shell-Mex and B.P. Limited hold a stock of some 280 million gallons of liquid fuel, which has to be kept warm. To do this a new boiler house has recently been installed, the steam from which will maintain the fuel at a temperature of up to 140 deg. F. and will also be used to operate the pumps which transfer petroleum products from ship to shore tanks and thence to bunkering vessels and road tankers. Industrial users will benefit from the new installation as the fuel will reach them at higher temperature and a further advantage will be that another step has been taken towards reducing smoke emission in the area.

The new steam-raising plant consists of two horizontal "Thermax" boilers of the three-pass wet-back type, which are manufactured by Ruston and Hornsby, Limited, Lincoln, each boiler having an output of 10,000 lb. per hour at a pressure of 150 lb. per sq. in. Oil with a viscosity of Redwood 1 at 100 deg. F. is used as a fuel, the firing equipment consisting of twin burners made by the Wallsend Slipway and Engineering Company, Limited, Wallsend, and air distributors on each furnace front. Supply is effected by two electrically driven pumps of the Rotoplunge horizontal gear type, which are driven by 5 h.p. totally enclosed fan cooled motors and have an output of 4,000 lb. per hour at a pressure of 200 lb. per sq. in. Thermostatic control is used to maintain the fuel at a predetermined temperature.

AUTOMATIC FIRING CONTROL

Automatic control of the firing is effected by apparatus of the electro-hydraulic type, which regulates the rate of flow of fuel to the furnace as well as the fan speeds and the induced draught. The system is operated from a panel on which instruments for controlling the smoke, a steam flow indicator and recorder, feed water, fuel oil temperature and steam pressure recorders and motor starters are also mounted. This part of the equipment was supplied by Evershed and Vignoles, Limited, Acton-lane Works, Chiswick, London, W.4.

The feed water is pre-heated in a separate tank from which it is supplied to the boilers by pumps manufactured by J. P. Hall and Sons, Limited, Peterborough. The water flow is regulated by thermo-feed equipment supplied by Ronald Trist and Company, Limited, Slough, who also installed Hilo water alarms.

The water gases are discharged through a horizontal flue into a 52 ft. chimney, the height of which has been reduced by using of an induced-draught fan. In accordance with the recommendation of the Institute of Petroleum it is protected from lightning by two air terminals on opposite diameters and by two down conductors, which are bonded together by a copper strip both above and below the rim. Each conductor has a separate earthing electrode.

Smoke discharge is controlled by a photo-electric system made by Radio Visor Parent, Limited, Stanhope-street, London, N.W.1, the cell of which is mounted in the horizontal flue near the base of the chimney. This cell is connected to a single-stage amplifier and pilot indicating meter which can be used for adjusting purposes, and thence to air indicating relay, alarm bell and recording chart calibrated on the Ringelmann scale.

* * *

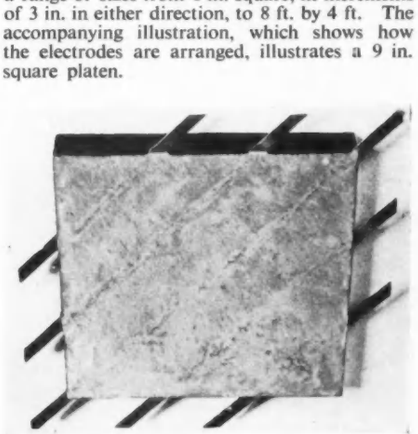
UNIVERSAL PLATEN FOR R-F HEATING

No Jigs Required

A new type of universal platen designed to increase the versatility of radio-frequency heating equipment, such as is increasingly used in furniture manufacture, has been developed by Technical Resin Bonders, East Road Hall, 46 East-road, Cambridge. This platen obviates the need for individual jigs, so that it can be used without modification for a wide variety of products. It has no exposed electrodes on the heating surface and arcing has been eliminated.

The T.R.B. universal platen consists of a number of brass electrodes spaced at approximately 2 in. centres, set at an angle of 45 deg. and embedded in a mixture of Araldite epoxy resin and a carefully chosen blend of fillers. The face of the platen, which is applied directly over the electrodes, is made from the same mixture of Araldite and fillers reinforced with glass cloth. To the back of the platen is fixed a thick sheet of plywood. The total thickness of the platen and plywood backing is 1¾ in.

Alternate electrodes are coupled together and thence to the radio-frequency generator. When the latter is switched on, the whole area of the platen is covered with radio-frequency "stray field" heating. The T.R.B. platen is available in a range of sizes from 6 in. square, in increments of 3 in. in either direction, to 8 ft. by 4 ft. The accompanying illustration, which shows how the electrodes are arranged, illustrates a 9 in. square platen.



The brass electrodes of the T.R.B. Universal radio-frequency heating platen are embedded in a mixture of Araldite and blended fillers.

" Widdecombe Fair "—a secular design for a stained-glass window by Leslie H. B. Collins.

MANY COLOURED GLASS

The essence of a window is the power to transmit light, and the more light transmitted the better the window. But rules, however admirable, have their exceptions and the historic practice of adding to the grace of architectural interiors by staining glass is a valuable and lovely tradition. Writing of the Dominician chapel at Vence in the South of France, for which the painter Matisse designed the windows, Basil Spence, architect of the new Coventry Cathedral, says: ". . . when I visit this building I feel that I have stepped into the centre of a pearl. The glass here is a part of the architecture." Stained glass may bring a fresh quality to modern buildings, secular as well as ecclesiastical, and again take its place as an integral feature of architectural design.

Helping to revive interest in the craft are two exhibitions, one, by the British Society of Master Glass-Painters, at the Building Centre where an impressive range of stained glass, illustrating various styles and techniques, is on view, and the other at the Victoria and Albert Museum, where may be seen the overwhelming splendour of the windows for Coventry Cathedral. The making of stained-glass windows is a craft requiring both ingenuity and technical knowledge. Indeed, it is one of the few crafts that cannot ostensibly be displaced by the repetition techniques of modern industry.

Part of a window in glass and concrete by Colwyn Morris. The use of concrete instead of lead as the matrix is unusual, but the simple mosaic, with little or no drawing, is of very early origin.

A stained-glass window is simply a translucent mosaic held together in a matrix of lead, which not only serves as the connecting medium, but also contributes to the design. It is interesting that a similar outlining technique—which in this case has no practical function—has been assimilated to the pictorial style of the painter Rouault. The art of colouring glass is known to have been practised as early as the Fifth Century and the use of coloured glass in a mosaic may have come from Byzantium or Ravenna, famous for their beautiful stone mosaics. It was between the Tenth and Fourteenth Centuries, and in conjunction with Gothic architecture, however, that the craft achieved its highest expression.

The monk Theophilus, who lived in the early part of this period, has described some of the methods employed. Illuminators would prepare the first drawings, but the actual cartoon for the glass was outlined on one end of a white-washed board supported on trestles. The other end was used for laying out the glass and for the general work of glazing. It is said that Theophilus " drew his figures with strips of lead, ground up his colours with wine or urine, and made his own brushes out of the hair of a marten, the tail of a cat, or the mane of an ass." The glass was shaped in accordance with the cartoon, which would be marked to indicate the various colours. The first rough cut would be taken with a hot iron and then a finishing cut with a tool known as the " grozing iron," a flat bar with a notch at one end and similar in appearance to a modern spanner. Diamond cutting did not appear until early in the Sixteenth Century, when the art of stained glass was already declining.

Before considering the problem of colouring, we can outline the methods by which glass for windows is prepared. There are four traditional techniques. In the first, the molten " metal " (glass) is simply poured on to a hot stone or metal slab to cool. Another approach is to blow the glass into a bulb and then form it to a cylinder; this is cut, heated in an oven and when ductile spread out flat. This is called muff glass. In the third method, the glass is blown in a similar manner and the bulb then opened and formed into a circular disc by spinning it. The result is known as spun or Crown glass and has a boss or bull's eye in the centre. Finally, there is a modern technique which produces what is known as slab glass; in this case the glass is blown into a cubical mould so forming a box; the sides and bottom are then separated.

After the glass has been prepared it has to be cut to shape and inserted in the lead matrix. This process of leading has remained almost unchanged. The lead is made in strips known as " calmes," which in section resemble the letter H, but with a thicker cross bar to represent the lead " core "; the upright strokes correspond to the " tapes." At first, the leads were cast, but in the Seventeenth Century the lead vice was introduced. It operated like a mangle and had two milled wheels, between which strip lead was squeezed, so producing the H-form. The wheels were sometimes engraved with the glaziers' names, and these names may often be found on old leading. Nowadays the lead sections are generally extruded. When the leads, cut to length and bent to shape, had been inserted between the pieces of grozed glass, they were soldered together at the junctions, and cement or putty was rubbed into the crevices between glass and lead. The complete window was then fixed into place by means of leaden strips soldered to the leads, or by copper wire, and attached to iron saddle-bars let into the masonry. Larger windows would be made in smaller units, known as " lights," which were fitted into an iron framework or " armature." This itself often formed a geometrical design contributing to the general effect of the window.

Originally, the designs were simply decorative mosaic patterns of jewelled pot glasses, deep and uniform in colour, though not always in tone, or if figures were introduced they would only be defined by the arrangement of the single-colour glass elements and the outline of the leading. The depth of colouring, variation in tone and the pearly effect of weathering has, however, given such windows an exquisite beauty. Subsequently an opaque brown pigment, applied as in a pen drawing, came into use, with which human features, the draping of garments and other details could be added; it also enabled the artist, by stippling or hatching, to modify the basic colours of the glass. The pigment would be fused on to the glass and so retained permanently. This may have led to *grisaille*, a later technique in which a pigment, consisting probably of iron oxide mixed with ground glass and sufficient gum to make the mixture adhere prior to firing, was applied to a grey glass having a greenish tinge—sometimes a touch of colour was also introduced—to supplement the lead outline and form patterns, heraldic devices or pictures.

The technique of flashing had also been developed in which the blower would gather some molten white glass on the end of his blowing iron and cover this with a thin film of, say, molten ruby. This not only served to reduce the depth of colour and to produce new colours by combination, but also permitted designs to be formed by removing areas of colour to reveal the clear

Detail of a cartoon for " The Last Supper," by R. L. Hendra. The glass is cut to shape, placed over the outline and fitted the lead " calmes."

Each window for the new Coventry Cathedral has a dominating colour representing some phase in human life or divine revelation. This "red window" situated on the "God side" of the nave has been designed by Lawrence Lee.

glass. This was effected by abrading the composite sheet on one side and later by use of hydrofluoric acid. Another important development was the discovery in the Fourteenth Century of a yellow stain derived from a solution of silver, which when applied to clear glass varied in tone from pale lemon yellow to deep orange, and, added to blue glass, produced a brilliant green. After the Fourteenth Century, when "pot-metals"—glasses coloured throughout their substance—started to be scarce, the use of enamels became common, being simply painted on to the glass and fired, but these gave a poor quality and were impermanent.

Few artists would deny that an intimate knowledge of technique is essential to the pursuit of any art, for in a sense the technique creates the character of the art and is inextricably bound up with it. Thus if there have been any technical developments since stained glass was first used in the Gothic cathedrals we might expect to see them embodied in the styles of to-day. In fact there have been few of any value. Some new colouring chemicals have been discovered, and except for one—a shade of ruby—most of the brilliant mediaeval colours can still be reproduced. But broadly, apart from the unsatisfactory application of enamel, there has been little progress.

However, a new interest seems recently to have arisen. At the Royal College of Art, where Lawrence Lee, one of those contributing to the Coventry windows, is head of the Department of Stained Glass, some fresh and vigorous designs have been evolved. The exhibition by the British Society of Master Glass-Painters also appears to be indicative of a growing desire to experiment. Concrete has been used instead of lead as the matrix in one example, and an odd wire figure immured within two glass sheets has made an appearance. But oddity is not he essence of development and something cognate to our age and to the natural use of modern materials and methods has yet to emerge. Stained-glass windows might have profited from the now waning fashion of the abstract, since with their splendid resource to colour they have no immediate need to be significant, and in the Coventry glass, with its near monochromatic scales, there is an approach to that.

But for any art to flourish there must be a call for it. The Master Glass-Painters in the guide to their exhibition state that one of their aims is to "show the scope of stained glass in secular buildings as well as in churches." Cathedrals are not built every day, and new churches are only common after a war. No one would suggest that men should work or play in the half light in which they are accustomed to worship—where there are several windows, one that is coloured does, after all, exclude very little light. Usefulness is often a poor criterion, but stained glass might serve to hide from us those vistas from home or office which are too unsightly to be pleasing—in some industrial cities such aspects must be common. In Victorian times stained glass was sometimes used, too, to light the bathroom, while concealing the bather from passers-by. But normally, stained glass exists to give pleasure. The scientist Bocker in John Wyndham's novel *The Kraken Wakes* says: "Call me a Philistine, if you like, but Art really only became Art in the last two centuries. Essentially, before that, it was furniture for improving one's home." True, and home is where we live, in cities and villages. Public buildings, the entrance halls of offices, meeting places both sacred and secular, all might add colour to daily life if some of the light we required our windows to transmit were transformed instead.

The transmuting quality of stained glass led Shelley to compare it to life itself:

> Life, like a dome of many-coloured glass,
> Stains the white radiance of Eternity.

A craft that can evoke such an image well deserves the renaissance that it seems at present to be undergoing.

Of related interest are the following books, reference to which has been made in preparing this article: *English Church Craftsmanship* by Fred H. Crossley; *English Town Crafts* by Norman Wymer; *English Stained Glass* by Herbert Read; *Treatise on the Art of Glass Painting* by E. R. Suffling; *Stained Glass Windows*, William Morris and Company; and the *Encylopaedia Britannica*.

FASTER MARSHALLING

The Eastern Region of British Railways are to speed up shunting operations in the Wath Hump marshalling yard by the installation of very high frequency radio telephone equipment. At the present time trains arriving at Wath are propelled to the top of the Hump by Diesel locomotives and the wagons then gravitate to the various sidings to form outgoing trains. These movements have been controlled by fixed signals and by transmitting messages to the drivers by hooters. This was satisfactory so long as steam locomotives with open cabs were used, but gave rise to difficulty with Diesel locomotives having enclosed cabs.

Radio telephony will also enable clearer instructions to be given than with the hooter system. For example, the driver can be told how many wagons are to be released on each shunt, thus facilitating his control of the speed necessary to push them over the hump. During fog and bad visibility, too, it will be beneficial from the safety point of view and as a means of avoiding delay. The equipment, which should be in operation within six months, is to be supplied and installed by Marconi's Wireless Telegraph Company, Limited, Chelmsford.

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AIR CONDITIONING UNIT

Domestic or Industrial Equipment on the Heat Pump Principle

A range of air conditioning units which employ the heat pump principle is to be marketed by Denco Miller, Limited, Hereford. One of these, the prototype of which was recently exhibited in London, is designed to operate in conjunction with a plenum system for space heating. An electrically-driven compressor, with either a 2, 3 or 4 h.p. motor, according to the size required, is used and a centrifugal fan circulates the heated air into the system. Air is drawn from outside the building by a second centrifugal fan and passed over the evaporator, supplying the heat needed from the low-temperature source. An automatic defrosting device is incorporated. During summer the cycle can be reversed so that the building is cooled instead of being heated, and for this to be done the evaporator and condenser are fitted with automatic valves. A refrigeration compartment can be added to the unit if desired.

As an example of the output of these units, each kilowatt of electrical energy will give approximately 10,000 B.Th.U. per hour and the 4 h.p. unit, therefore, will give an output of 40,000 B.Th.U. per hour when the outside temperature is approximately 45 deg. F. Where multi-purpose units are concerned, as when water-heating and refrigeration duties are included, an independent compressor is used for these two functions. A free-standing unit is manufactured but normally the majority of units will be built into the house.

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DEFENCE AGAINST THE HYDROGEN BOMB

The effects of radiation, heat and blast from a 10 megaton hydrogen bomb are displayed in a Home Office Civil Defence Training Film, which is available on hire from the Central Film Libraries and is also on sale. The object of the film is to indicate the civil defence measures that would become necessary and it is based on the information contained in "Nuclear Weapons," the official training manual. It fulfils this task satisfactorily, the result being both sombre and alarming. It is, however, felt that the public should not be left unaware of the varied and widespread effects which would follow the use of such a weapon. The production by R.H.R. Productions Limited and the acting are both excellent.

CORRECTING ORIFICE METERS FOR PULSATING FLOW

SIGNIFICANCE OF WAVE FORM AND ACOUSTIC EFFECTS

By M. V. Nesbitt, B.E. (SYDNEY)*

When an orifice meter, normally used to meter the steady flow of a fluid, is used to measure pulsating flow serious errors in results may occur. This problem of metering pulsating flow has received attention over the past 40 years and it would appear[1] that analysis related to an incompressible medium has reached the stage where codes of practice might give specific instructions, but the problem of metering compressible pulsating flow still requires much research before it can attain the same status. The complexity of this problem has recently been indicated by Zarek[2].

In this article a simple analysis has been made of the British Standard flow formula for orifice meters used under pulsating conditions and an attempt made to emphasise the importance of wave forms and amplitudes, pointing out how the acoustic properties of the system fit into the picture. That the former are important is well known[3] but, as far as the author knows, there has been no experimental work done to assess the magnitude of the effect of changing wave form, and acoustic properties have been almost neglected.

The analysis has been carried out in three steps. First, it is assumed that the overall coefficient of discharge remains constant, and the errors found for rectangular and sine wave variations of upstream pressure and differential head. Second, the effect of pulsation on the coefficient of expansion is investigated, and the errors calculated for rectangular waves of upstream pressure and differential head in order to assess the maximum magnitude of the effect. Third, calculations indicate the change in the correction factor for Reynolds number effects.

The assumptions made are: (1) that it is possible to measure true mean pressures upstream and downstream of the meter and the true mean differential head; (2) that the waves at all stations are regular, have the same frequency and are in phase.

The analysis shows that the amplitudes and wave forms both upstream and downstream of the meter are vitally important in determining true flows. The effect of pulsation on the coefficient of expansion is small and can be readily accounted for, and the effect on the Reynolds number correction factor is negligible. It is pointed out that the acoustic properties are important from a practical viewpoint since they will determine the wave forms and amplitudes which will arise from a given source disturbance and how these will change with changes in flow.

CONSTANT DISCHARGE COEFFICIENT

Lindahl[3] has made an analysis similar to that below for the incompressible case and, as a result of his assumption of incompressibility, only the wave form and amplitude of the differential pressure appear to be important. In the following, compressible flow is assumed and it is shown that the amplitudes and wave forms upstream and downstream of the meter, or alternatively, the amplitudes and wave forms of the upstream and differential pressure waves, are important.

Consider first an orifice meter in which the absolute static pressures upstream and downstream of the meter are varying with rectangular wave forms $p'_u(1 \pm A)$ and $p'_d(1 \pm B)$ respectively and that the waves are in phase, where

p'_u = true mean upstream static pressure,
A = upstream amplitude coefficient,
p'_d = true mean downstream static pressure, and
B = downstream amplitude coefficient.

Following the empirical orifice meter equation of B.S. 1042 (1943)[4] and assuming that the overall discharge coefficient remains constant, the mass flow rate through the meter at any instant is given by:—

$$w \propto \{\rho_u (p_u - p_d)\}^{\frac{1}{2}} \quad . \quad . \quad (1)$$

where ρ_u = instantaneous upstream density,
p_u = instantaneous upstream static pressure, and
p_d = instantaneous downstream static pressure.

Since $p = k\rho^n$

where n = polytropic index,

$$w \propto \left\{ p_u^{\frac{1}{n}} (p_u - p_d) \right\}^{\frac{1}{2}} . \quad . \quad (2)$$

During the positive half cycles of both pressure waves, the mass flow is given by:—

$$w_1 \propto \frac{1}{2\eta} \left[\{p'_u (1 + A)\}^{\frac{1}{n}} \{p'_u (1 + A) - p'_d (1 + B)\} \right]^{\frac{1}{2}} \quad (3)$$

where η = frequency of oscillation.

Similarly, during the negative half of both cycles, the mass flow is given by:—

$$w_2 \propto \frac{1}{2\eta} \left[\{p'_u (1 - A)\}^{\frac{1}{n}} \{p'_u (1 - A) - p'_d (1 - B)\} \right]^{\frac{1}{2}} \quad (3a)$$

and the mass flow, measured as a rate, is therefore:—

$$W \propto (w_1 + w_2)\,\eta \, . \quad . \quad . \quad (4)$$

The ratio of the true mass flow rate to the flow rate as computed from mean pressures becomes:

$$r = \frac{\left[\left[\{p'_u(1+A)\}^{\frac{1}{n}} \{p'_u(1+A) - p'_d(1+B)\} \right]^{\frac{1}{2}} + \left[\{p'_u(1-A)\}^{\frac{1}{n}} \{p'_u(1-A) - p'_d(1-B)\} \right]^{\frac{1}{2}} \right]}{2 \left[(p'_u)^{\frac{1}{n}} (p'_u - p'_d) \right]^{\frac{1}{2}}} \quad . \quad . \quad . \quad (5)$$

which can be re-written as

$$r = \frac{\left[\left[(1+A)^{\frac{1}{n}} \{p'_u(1+A) - p'_d(1+B)\} \right]^{\frac{1}{2}} + \left[(1-A)^{\frac{1}{n}} \{p'_u(1-A) - p'_d(1-B)\} \right]^{\frac{1}{2}} \right]}{2 (p'_u - p'_d)^{\frac{1}{2}}} \quad . \quad . \quad . \quad (6)$$

To write this in terms of the differential head, let the equation of the differential head wave form be:—

$$h = h' (1 \pm C)$$

where

$$h' (1 + C) = p'_u (1 + A) - p'_d (1 + B)$$

and

$$h' (1 - C) = p'_u (1 - A) - p'_d (1 - B).$$

Then

$$r = \tfrac{1}{2} \left[\left\{ (1 + A)^{\frac{1}{n}} (1 + C) \right\}^{\frac{1}{2}} + \left\{ (1 - A)^{\frac{1}{n}} (1 - C) \right\}^{\frac{1}{2}} \right] . \quad (7)$$

This relation is shown plotted in Fig. 1 for values of A and C lying between 0 and 1 and for adiabatic conditions, i.e. $n = \gamma$. For obvious reasons A can never exceed unity and C is limited to less than unity since C greater than one signifies reverse flow at some stage of the cycle; in such a case the above analysis breaks down, although it is possible to treat such a condition by a similar but slightly more complex procedure.

If the static pressures upstream and downstream of the meter are considered to be varying in phase with sine-wave forms

$$p_u = p'_u (1 + A \sin \theta)$$

and

$$p_d = p'_d (1 + B \sin \theta)$$

then the mass flow rate is given by:—

$$W \propto \frac{1}{2\pi} \int_0^{2\pi} \left[\{p'_u (1 + A \sin \theta)\}^{\frac{1}{n}} \{p'_u (1 + A \sin \theta) - p'_d (1 + B \sin \theta)\} \right]^{\frac{1}{2}} d\theta \quad (8)$$

and $r =$

$$\frac{\left[\int_0^{2\pi} \left[\{p'_u (1 + A \sin \theta)\}^{\frac{1}{n}} \{p'_u (1 + A \sin \theta) - p'_d (1 + B \sin \theta)\} \right]^{\frac{1}{2}} d\theta \right]}{2\pi \left[(p'_u)^{\frac{1}{n}} (p'_u - p'_d) \right]^{\frac{1}{2}}}$$

$$= \frac{\left[\int_0^{2\pi} \left[(1 + A \sin \theta)^{\frac{1}{n}} \{p'_u (1 + A \sin \theta) - p'_d (1 + B \sin \theta)\} \right]^{\frac{1}{2}} d\theta \right]}{2\pi (p'_u - p'_d)^{\frac{1}{2}}} \quad . \quad . \quad . \quad (9)$$

For this case

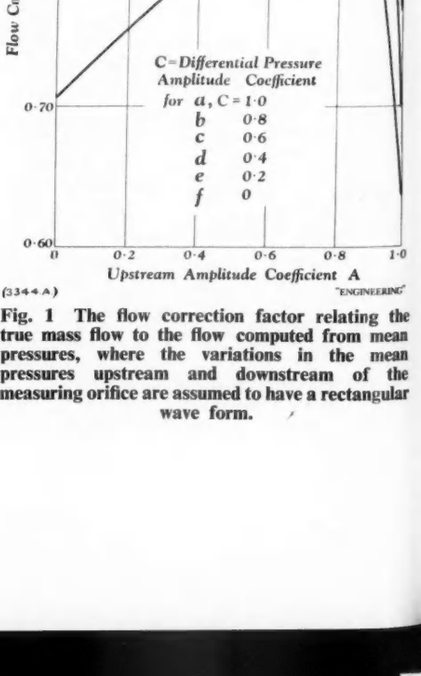
$$h = h' (1 + C \sin \theta)$$

and

$$r = \frac{\int_0^{2\pi} \left[(1 + A \sin \theta)^{\frac{1}{n}} (1 + C \sin \theta) \right]^{\frac{1}{2}} d\theta}{2\pi} . \quad (10)$$

Expanding and integrating equation (10) for adiabatic conditions yields:—

$$r = 1 + [-0{\cdot}0574\,A^2 + 0{\cdot}0895\,CA - 0{\cdot}0625\,C^2] + [-0{\cdot}01148\,A^4 + 0{\cdot}01179\,CA^3 + 0{\cdot}00538\,C^2A^2 + 0{\cdot}00836\,AC^3 - 0{\cdot}01464\,C^4] + [-0{\cdot}007319\,A^6 + 0{\cdot}004728\,A^5C + 0{\cdot}004302\,A^4C^2 + 0{\cdot}005348\,A^3C^3 + 0{\cdot}001401\,A^2C^4 + 0{\cdot}003051\,AC^5 - 0{\cdot}006409\,C^6] . \quad . \quad . \quad (11)$$



(3344-A) "ENGINEERING"

Fig. 1 The flow correction factor relating the true mass flow to the flow computed from mean pressures, where the variations in the mean pressures upstream and downstream of the measuring orifice are assumed to have a rectangular wave form.

* Aeronautical Research Laboratories, Department of Supply, Australia.

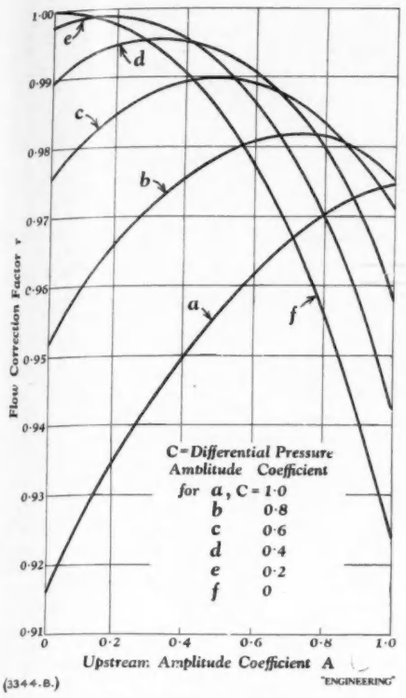


Fig. 2 The flow correction factor for assumed sine wave variations in the mean pressures.

Computation shows that terms involving powers to the eight and higher are negligible. In Fig. 2 the relationship of equation (11) has been plotted for values of A and C lying between zero and unity.

Equations (6), (7), (9) and (10) show that in correcting flow rates calculated from measurements of true mean pressures, two wave forms and two amplitudes are important: either the amplitudes and wave forms upstream and downstream of the meter or the amplitudes and wave forms of the upstream and the differential pressure waves.

In the general case, the upstream, downstream and differential pressure waves will have different wave forms so that the ratio is given by:—

$$r = \frac{\left[\int_0^{2\pi}\left[(1+Af'(\theta))^{\frac{1}{n}}\{p'_u(1+Af'(\theta)) - p'_d(1+Bf''(\theta))\}\right]^{\frac{1}{2}} d\theta\right]}{2\pi(p'_u - p'_d)^{\frac{1}{2}}} \quad . \quad . \quad . \quad (12)$$

or

$$r = \frac{\int_0^{2\pi}\left[(1+Af'(\theta))^{\frac{1}{n}}(1+Cf'''(\theta))\right]^{\frac{1}{2}} d\theta}{2\pi} \quad (13)$$

where

$f'(\theta)$, $f''(\theta)$ and $f'''(\theta)$

are Fourier functions giving the wave forms of upstream, downstream and differential pressure waves respectively.

PULSATION AND THE COEFFICIENT OF EXPANSION

Examination of figure 23*a* of the British Standard[4] shows that for a given ratio of meter to pipe area $\left(\text{i.e. } \left(\frac{d}{D}\right)^2 = m\right)$ the coefficient of expansion ϵ is given by

$$(1-\epsilon) = k\left(1 - \frac{p_2}{p_1}\right). \quad . \quad (14)$$

where

k = constant,
p_1 = upstream static pressure, and
p_2 = downstream static pressure.

Equation (14) reduces to:—

$$1 - \epsilon = k\left(\frac{h}{p_1}\right) \quad . \quad . \quad (15)$$

where h = the differential head.

It can be seen that changes in h and p during pulsation will affect the value of ϵ. To assess the order of errors produced by cyclic changes in ϵ consideration is now given to rectangular upstream and differential pressure waves represented by equations

$$p = p'_u(1 \pm A)$$
$$h = h'(1 \pm C)$$

respectively.

Considering the positive half-cycles of both waves (which are assumed to be in phase)

$$1 - \epsilon_+ = k\frac{h'}{p'_u}\left(\frac{1+C}{1+A}\right). \quad . \quad (16)$$

The average value of ϵ determined from measurements of true mean pressures is given by

$$1 - \epsilon_{av} = k\frac{h'}{p'_u} \quad . \quad . \quad (17)$$

$$\frac{1-\epsilon_+}{1-\epsilon_{av}} = \frac{1+C}{1+A}$$

or $$-\epsilon_+ = \left(\frac{A-C}{1+A}\right) + \left(\frac{1+C}{1+A}\right)\epsilon_{av}. \quad (18)$$

Similarly, during the negative half of both cycles,

$$\epsilon_- = \left(\frac{C-A}{1-A}\right) + \left(\frac{1-C}{1-A}\right)\epsilon_{av}. \quad (19)$$

The ratio of true mass flow rate to mass flow rate computed from true mean pressures then becomes, for rectangular waves:—

$$r = \frac{\left[\epsilon_+\left\{(1+A)^{\frac{1}{n}}(1+C)\right\}^{\frac{1}{2}} + \epsilon_-\left\{(1-A)^{\frac{1}{n}}(1-C)\right\}^{\frac{1}{2}}\right]}{2\epsilon_{av}} \quad . \quad . \quad . \quad (20)$$

In Fig. 3, equation (20) is plotted for $\epsilon_{av} = 0{\cdot}96$ and values of A and C between zero and unity. Comparison with Fig. 1 indicates that errors due to change in the coefficient of expansion during pulsation are appreciable but small compared to those due to the effect of pulsation on p and h. Since rectangular wave form represents the greatest source of error, it can be expected that, for wave forms approaching a sine wave, the errors due to a cyclic change in the coefficient of expansion will be reduced considerably.

REYNOLDS NUMBER CORRECTION

Examination of Fig. 19b of the British Standard[4] shows that for a specific area ratio of meter to pipe, the Reynolds number correction factor is given by

$$y = k_1 - k_2 \log_{10} \mathrm{RN}$$

where y is the Reynolds number (RN) correction factor, and k_1, k_2 are constants for the particular area ratio.

Taking as a representative value $m = \left(\frac{d}{D}\right)^2 = 0{\cdot}4$, this becomes:—

$$y = 1{\cdot}0884 - 0{\cdot}01523 \log_{10} \mathrm{RN}$$

from which

$$\mathrm{RN} = 10^{(71{\cdot}4642 - 65{\cdot}6599\,y)} \quad . \quad . \quad (21)$$

Since

$$\mathrm{RN} = \frac{\rho v d}{\mu}$$

and if viscosity is assumed to be constant during pulsation $\left(\text{i.e., for constant } \frac{d}{\mu}\right)$ we may write

$$\mathrm{RN} \propto \rho v$$

and

$$\mathrm{RN} \propto \rho a v \quad . \quad . \quad (22)$$

where a = the area of the meter.

Since the coefficient of discharge and the velocity of approach factor are functions only of the meter geometry, equation (22) may be written

$$\mathrm{RN} \propto \rho a v \propto y\epsilon\left\{\rho_u(p_u - p_d)\right\}^{\frac{1}{2}}.$$

If, in order to assess the magnitude of the effect of pulsation on the Reynolds number factor, rectangular pressure waves of upstream pressure and differential head are assumed, during the positive half cycles of both waves

$$\frac{\mathrm{RN}_+}{\mathrm{RN}_{av}} = \frac{(\rho a v)_+}{(\rho a v)_{av}} = \frac{y_+\epsilon_+\left\{(1+A)^{\frac{1}{n}}(1+C)\right\}^{\frac{1}{2}}}{\epsilon_{av} y_{av}}. \quad . \quad . \quad . \quad (23)$$

Combining equations (21) and (23), then, for $m = 0{\cdot}4$,

$$\frac{y_+\epsilon_+\left\{(1+A)^{\frac{1}{n}}(1+C)\right\}^{\frac{1}{2}}}{y_{av}\epsilon_{av}} = \frac{10^{(71{\cdot}4642 - 65{\cdot}6599\,y_+)}}{10^{(71{\cdot}4642 - 65{\cdot}6599\,y_{av})}}$$

from which

$$\log_{10} y_+ + 65{\cdot}6599\,y_+ = 65{\cdot}6599\,y_{av} + \log_{10}\epsilon_{av} y_{av} - \log_{10}\epsilon_-\left\{(1+A)^{\frac{1}{n}}(1+C)\right\}^{\frac{1}{2}}. \quad . \quad . \quad . \quad (24)$$

Similarly, for the negative half of both cycles:—

$$\log_{10} y_- + 65{\cdot}6599\,y_- = 65{\cdot}6599\,y_{av} + \log_{10}\epsilon_{av} y_{av} - \log_{10}\epsilon_-\left\{(1-A)^{\frac{1}{n}}(1-C)\right\}^{\frac{1}{2}}. \quad . \quad . \quad . \quad (25)$$

Using the values of y_+ and y_- obtained from equations (24) and (25), the ratio of true mass flow rate to the mass flow rate computed from true mean pressures is, for rectangular waves:—

$$r = \frac{\left[y_+\epsilon_+\left\{(1+A)^{\frac{1}{n}}(1+C)\right\}^{\frac{1}{2}} + y_-\epsilon_-\left\{(1-A)^{\frac{1}{n}}(1-C)\right\}^{\frac{1}{2}}\right]}{2 y_{av}\epsilon_{av}} \quad . \quad . \quad . \quad (26)$$

This ratio was computed for $\epsilon_{av} = 0{\cdot}96$, $m = 0{\cdot}4$, $y_{av} = 1{\cdot}02$ and for A and C in the range 0 to 0·8. Examination of equation (25) shows that for A or C equal to unity y_- is indeterminate.

All computations showed that, considering only the pressure terms and effects of pulsation

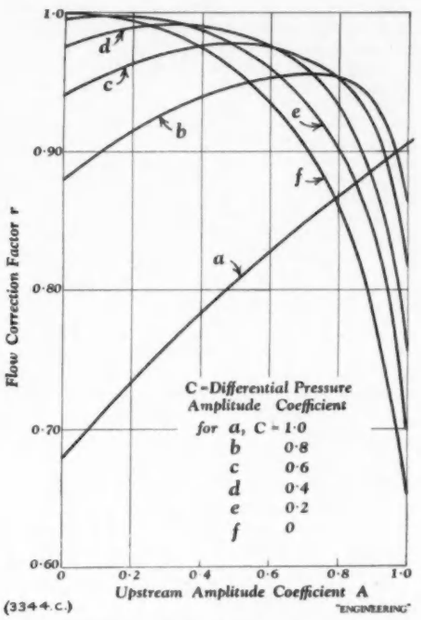


Fig. 3 The correction factor of Fig. 1, but modified by consideration of the effects of pulsation on the average coefficient of expansion of $\epsilon_{av} = 0{\cdot}96$.

on the coefficient of expansion, taking Reynolds number effects into account under pulsating conditions had negligible effect upon the value of r obtained. Table I compares the values of r obtained considering only the effects on the

TABLE I.

C	A	r Corrected for effects on coefficient of expansion	r Corrected for effects on coefficient of expansion and Reynolds number factor
0·6	0	0·9408	0·9409
	0·2	0·9637	0·9635
	0·4	0·9761	0·9756
	0·6	0·9754	0·9746
	0·8	0·9541	0·9731
0	0	1·0000	1·0000
	0·2	0·9943	0·9944
	0·4	0·9754	0·9755
	0·6	0·9382	0·9383
	0·8	0·8626	0·8628

coefficient of expansion and those for the effects on the coefficient of expansion and the Reynolds number factor.

ACOUSTIC PROPERTIES

In the preceding theory, the acoustic properties play no part at all and for a given meter, provided that the amplitudes and wave forms can be determined for each reading desired, no further consideration need be given to the acoustic properties of the metering arrangements. However, it is desirable from a practical point of view to know for a given arrangement and a given source disturbance what the wave forms and amplitudes will be under all conditions without the necessity of elaborate measuring techniques. It is in this connection that the acoustic properties become important.

Some idea of the complexity of this problem has already been given[5]. This paper deals with the reflection and transmission of pressure disturbances at area changes under ideal conditions but there is no reason to believe that the qualitative conclusions will not apply to the practical case. Assuming that this is so, then for a given source disturbance upstream of the meter, reflections from the meter will depend upon the area ratio of the meter and the flow Mach number. Also, secondary reflection of disturbances reflected upstream from the meter will depend upon the upstream ductwork arrangement. Thus, the upstream amplitude coefficient A is dependent not only upon the source of pressure fluctuations but also upon the meter and ductwork geometry. The resultant wave shape will also depend upon these quantities. The downstream amplitude coefficient B will depend upon upstream conditions as well as meter geometry, downstream ductwork arrangement and flow Mach number.

It is easily seen that this problem is complex in the extreme and considerable research is needed before any simple means of determining wave shapes and amplitudes from a given source disturbance is available.

CONCLUSIONS

The simple theoretical treatment given shows that, in using an orifice plate for metering compressible pulsating flow, the following factors are of importance in determining the true flow rate:—amplitudes of oscillation upstream and downstream of the meter, or amplitudes of oscillation of the upstream and differential pressure waves; and the wave forms corresponding to these amplitudes.

Examination of the effect of pulsation on the coefficient of expansion shows a small effect for rectangular wave forms and this effect could be expected to be smaller for other wave shapes. Calculations also show that pulsation has a little effect upon the Reynolds number factor.

Investigation of acoustical effects is not essential to solution of the problem of metering compressible pulsating flow but from a practical point of view a knowledge of these properties would assist in the determination of wave shapes and amplitudes without the use of complex measuring techniques.

It would appear from this analysis that two of the wave forms and amplitudes mentioned above are vital to obtaining a true correction to the flow and an experimental investigation of the effect of changing wave forms should prove most instructive. The difficulties of assessing the wave form of a practical wave are realised but it is felt that some experimental work along these lines is essential to the solution of this problem. It might also be mentioned here that in surveying the literature in this field one cannot help but feel that too little attention has been paid to the behaviour of manometers under pulsating conditions and it would seem that attention to this would greatly assist in the solution of the broad problem of metering.

Acknowledgment: This article is communicated by permission of the Chief Scientist, Department of Supply, Melbourne, Australia.

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EXHAUST TURBOCHARGERS FOR DIESEL ENGINES

DISCHARGE TO WASTE-HEAT BOILERS

The first two sizes of a new range of air-cooled turbochargers are now in production by the Brush Electrical Engineering Company, Limited, Loughborough, Leicestershire. They employ a single-stage exhaust-driven axial-flow turbine driving a single-stage centrifugal impeller delivering air to the induction manifold of the engine. Due to the small heat loss from the turbine casings, they are suitable for use in conjunction with waste-heat boilers. At present they are available in two frame sizes, designated the 20 and 30 series, and in two maximum continuous boost ratings, 9 lb. and 15 lb. per sq. in. respectively. Their specifications and capacities are given in Tables I and II, and the appearance and construction may be appreciated by consideration of Figs. 1 and 2.

TABLE I *Specification*

Maximum Continuous Rating*	MB20	MB30	HB20	HB30
Boost pressure, lb. per sq. in. (gauge at S.L.)	9	9	15	15
Turbine inlet temperature, deg. C.	650	650	650	650
Speed, r.p.m.	16,000	12,200	20,000	15,250
Approximate weight	650 lb.		1,150 lb.	
Length	3 ft. 0 in.		3 ft. 9 in.	
Width	2 ft. 6 in.		3 ft. 0 in.	
Height	2 ft. 6 in.		3 ft. 0 in.	

* Maximum 1-hour rating, 10 per cent. increase in speed.

TABLE II *Approximate Free Air Capacities**

	MB20	MB30	MB20	MB30	HB20	HB30
Boost pressure, lb. per sq. in.	5		9		15	
Min. flow, cub. ft. per min.	1,150	2,250	1,150	2,900	2,200	3,850
Max. flow, cub. ft. per min.	2,300	4,450	3,050	5,550	4,000	6,900

* These capacities correspond approximately to engine supercharged output ranges of:

400 to 1,500 b.h.p. at 5 lb. per sq. in. boost pressure.
520 to 1,850 b.h.p. at 9 lb. per sq. in boost pressure.
730 to 2,300 b.h.p. at 15 lb. per sq. in. boost pressure.

For a given frame size of turbocharger to operate successfully on a variety of engines, it is necessary to vary the size of certain components in order to match the turbocharger characteristics with those of the engine. In the Brush series of turbochargers, mass flow and boost pressure requirements are varied by changing the compressor diffuser area, the turbine-blade height, and the turbine nozzle-ring throat area.

The Brush turbocharger is designed to give a wide variety of alternative compressor and turbine casing positions so that the unit can be adapted to suit different installations. Two, three and four-entry turbine casings are available for engines with different exhaust systems. The turbine bearing and intake bearing mounting are always mounted in the vertical position to allow correct oil drainage, but this does not affect the choice of position for compressor and turbine casings and mounting foot. Units may be fitted with a variable-position air intake or a large-capacity air filter of the three-ply oil-wetted fabric type. For high boost-pressure operation, intercoolers can be supplied for each size of turbocharger.

DIFFERENTIAL EXPANSION OVERCOME

The turbine inlet and outlet casings, cast in heat resisting material, are air cooled and therefore no cooling water supply is required. Heat shields are fitted over the casings to minimise heat radiation.

The compressor casings, consisting of a volute casing and a rear cover, are cast in light alloy. Differential expansion between the hot turbine-outlet casing and the relatively cool compressor rear cover is allowed for by the use of radial pins clamped by spring-plate assemblies. A similar arrangement centres the turbine bearing support casing in relation to the turbine inlet casing. By this means, the rotor assembly is maintained in correct alignment when the casings expand differentially at the working temperature, and it has thus been rendered possible to use fine blade-tip and impeller clearances to give high component efficiencies. Leakage of air from the impeller tip is minimised by a labyrinth ring attached to the rear cover plate. This ring is positioned to reduce the rotor end thrust to a minimum.

A light-alloy casing, spigoted to the compressor volute casing, forms the intake bearing mounting (Fig. 3). The central drum of this casing is an oil tank containing a worm-driven

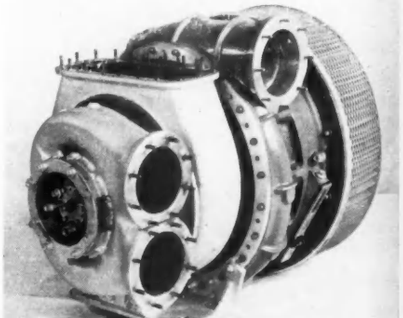

Fig. 1 The turbocharger seen from the turbine end. The turbine bearing support casing is centred in relation to the turbine inlet casing by radial-pin and spring-plate assemblies.

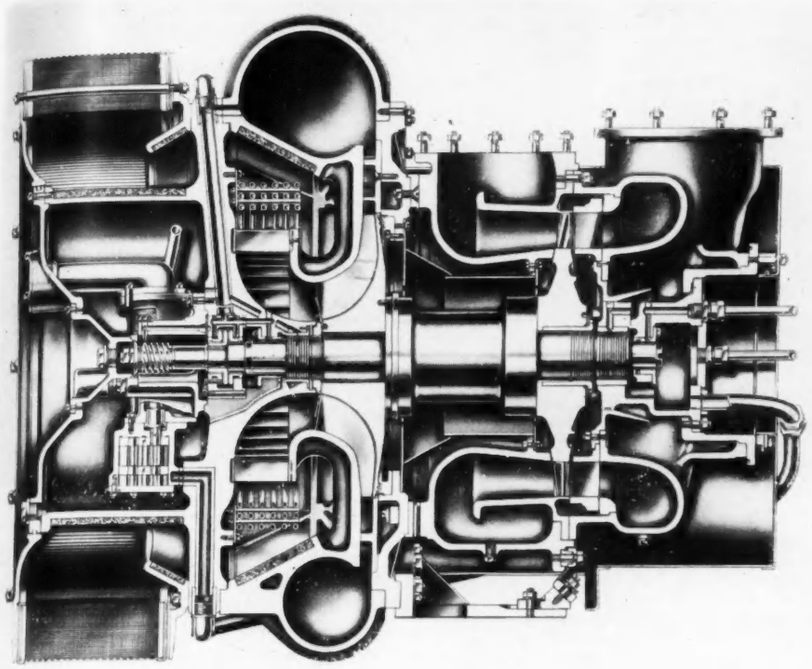

Fig. 2 The new Brush turbocharger employs a single-stage exhaust-driven axial-flow turbine driving a single-stage centrifugal impeller delivering air to the induction manifold of the engine. The turbine inlet and outlet casings are air cooled.

gear-type oil pump, a rotating oil/air separator, an oil relief valve, and a full-flow oil filter. The two-pass annular oil cooler, constructed of steel tubes, is mounted on the radial support arms of the intake bearing mounting and is thus positioned around the intake of the compressor. Internal pipework is reduced to a minimum by the adoption of cast-in tubes in the radial support arms which provide passages for oil and the labyrinth air supplies.

The rotor assembly consists of a steel shaft on to which are spigoted the centrifugal impeller and the turbine disc. The shaft is supported by two plain bearings. Axial movement is controlled by a thrust bearing adjacent to the compressor bearing. The journal surfaces are hardened and ground to ensure long and trouble-free service.

AUSTENITIC TURBINE BLADES WELDED TO DISC

The centrifugal impeller is machined from a light-alloy drop forging and has integrally-formed rotating guide vanes. The turbine disc is machined from an austenitic steel forging to which blades of similar material are welded. Gas and oil leakage along the rotor shaft is prevented by pressurised labyrinth seals supplied with air from the compressor volute.

Oil under pressure is passed through the annular cooler and full-flow fabric type filter before passing to the bearings. Oil from the turbine bearing is returned to the tank by scavenge pump, ensuring satisfactory operation of the turbocharger when permanently inclined in any direction at 15 deg. and for a momentary inclination of 22½ deg. An adjustable relief valve is provided for the oil pump and a by-pass valve, in parallel with the filter, operates only if the filter is allowed to become dirty. The oil-pump drive-shaft incorporates a centrifugal oil/air separator which reduces the oil content of the air vented from the breather.

DEVELOPMENT DIFFICULTIES

Design of the turbocharger began in 1949 and the first prototype ran on a Mirrlees engine in 1950. The performance obtained compared favourably with other turbochargers but considerable development was required to achieve satisfactory mechanical operation. Heat soakage to the turbine bearing after shut-down was one of the difficulties encountered. This problem was overcome by adopting a different method of location for the turbine disc on the rotor shaft. A centrifugal type oil/air separator was found to be necessary to vent the lubrication system satisfactorily, enabling the unit to operate with negligible oil consumption.

The reliability of the pump-drive gears at a speed of 20,000 r.p.m. was proved on a rig in which a worm-and-wormwheel assembly driving an oil pump was subjected to an endurance test of 6,000 hours. Inspections during this period revealed that wear was negligible and at the conclusion of the test the gears were in a satisfactory condition.

With the provision of the development test facilities, it was possible to rig-test the compressor and turbine components individually to determine their characteristics. Numerous tests have been made to achieve high component efficiencies and a wide operating range to minimise matching difficulties on engines. Compressor characteristics are obtained from a 250 h.p. motor-driven rig. Complete turbocharger units are run on a rig fitted with a combustion chamber system. The unit is run up by an electric starter motor and becomes self driving by the addition of fuel to the combustion chamber. Turbine characteristics and mechanical efficiency curves can be obtained by the combined operation of the compressor and turbine rigs. In this case, the compressor on the unit is used as a brake for measuring turbine power while the air to the turbine is supplied by the motor-driven compressor.

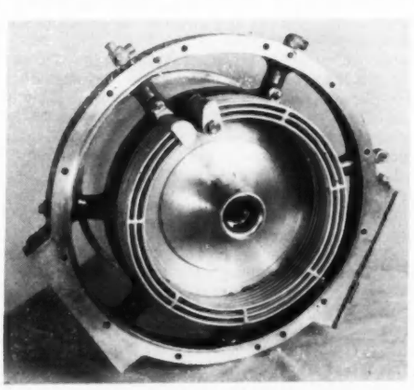

Fig. 3 A two-pass annular oil cooler is mounted on the radial support arms of the intake bearing mounting, the central drum of which forms the oil tank and houses the oil pump and oil/air separator.

In addition to performance development testing, mechanical reliability has been proved by endurance tests on complete units running self-driving gas-turbine units with a combustion chamber in the system.

A separate test house has recently been erected for carrying out the performance and overspeed tests at operating temperature on every production turbocharger. The facility comprises twin test cells, each with a combustion chamber system, in which the turbochargers are brought to self-driving speed by means of an engine-driven slave compressor. Both test cells are fully equipped to record all the necessary data and operation is from a separate sound-proofed control and instrument room.

Since 1950 prototype units have been running on engines at the works of the National Gas and Oil Engine Company, Limited, and Mirrlees, Bickerton and Day, Limited, and several thousands of running hours have been successfully completed. Pilot production of turbochargers started early in 1955, and running tests are continuing with the latest production type of turbocharger fitted to engines operating on works load.

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CHEMICAL ENGINEERING FELLOWSHIP IN AUSTRALIA

A Fellowship worth £1,000 (Australian) is offered in Chemical Engineering by the British Memorial Fund, established in Victoria, Australia by public subscription. The Fellowship is a gesture of " loyalty, gratitude and affection " to the British people in recognition of their " role in saving civilisation in the Second World War."

It provides for ten months' study in Victoria for the selected candidate and covers travelling and living expenses during the period.

The upper age limit for both men and women is 35 years, and applicants must be of British stock of at least 10 years' residence in the United Kingdom.

The necessary arrangements and general direction of research work will be the responsibility of I.C.I. Australia and New Zealand, Limited, who have their headquarters and major research facilities in the State of Victoria.

Full details can be obtained from Colonel the Hon. W. W. Leggatt, Agent-General for Victoria and Chairman of the British Memorial Fund, London Selection Committee, Victoria House, Melbourne Place, Strand, London, W.C.2. The closing date for the receipt of applications is September 15, 1956.

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BRITISH CHEMICAL STANDARDS

The Bureau of Analysed Samples, Ltd., Newham Hall, Middlesbrough, inform us that a number of new British Chemical Standards are now available. They include a nickel-cobalt-niobium permanent-magnet alloy, a 5 per cent-silicon aluminium alloy, three basic slags, a 34 per cent-alumina firebrick and a series of spectrographic standards of mild steels in the form of ¼ in. diameter rods, containing increments of a large number of residual elements.

Copies of the new list, No. 386, giving details of all the chemical standards available may be obtained post-free from the office of the Bureau, at the above address.

Fig. 1 Main grinding shop in the new factory.

Fig. 2 Gauging, inspection and testing section.

PERMANENT MAGNET MANUFACTURE

MODERN PRODUCTION METHODS AT SHEFFIELD

To meet the increased demand for both permanent magnets and magnetic tools, James Neill and Company (Sheffield), Limited, Napier-street, Sheffield 11, have recently opened a new factory on a site adjacent to their original works.

The ground floor of this new factory accommodates the main grinding shop, of which a view is given in Fig. 1. This is arranged so that the flow of work follows the correct sequence from the adjacent foundry, the latter having recently been equipped with sand-blast and rotary shot-blasting machines. High frequency ovens are employed for core drying and pallets are used for handling the moulding boxes. The equipment of the grinding shop itself includes a number of Snow vertical spindle machines, which facilitate rapid and economical jigging of the work and thus enable maximum utilisation of the plant to be obtained. A duplex grinder of the same make has been installed to give long runs and to permit parts with two parallel faces to be ground simultaneously. The horizontal machines with which the shop is equipped are fitted with Eclipse heavy-duty chucks of the firm's own manufacture. Production is facilitated by the employment of overhead runways for handling the heavier components, particularly over the open-sided machines. Some idea of the capacity of the shop may be gained from the statement that the aggregate horse-power of the motors installed is 506 h.p. Jigging for the main battery of grinding machines is carried out in a separate section, which is so arranged as to ensure a continuous flow of work.

The drilling, turning, milling and slotting sections of the factory, where the special magnets and the various components required in the manufacture of chucks and other magnetic tools are produced, are housed on the first floor. On the same floor is a component store and a production control section from which the various batches of parts are progressed through the factory. The equipment in this part of the works consists of surface, internal and gap grinding machines. All of these are surmounted by extraction cowls through which the dust is drawn into a main duct leading to a fan house on the roof.

A supply of electricity is obtained from three main lines of busbars, an arrangement which facilitates any desired alteration in the positions of the machines. Permanent magnet chucks are employed on the machines on which silicon iron grids and mild steel plates are " gang-milled " as well as on the lathes for turning parallel discs and other second-operation jobs. The slots in the top plates of the magnetic chucks are trimmed in a vertical press instead of, as is usually the case, in a slotter.

The layout of the more important machines in this shop, particularly of the drills, is such that the unloading and re-loading of work from standard pallets (which are carried on 10 cwt. trucks) are facilitated. All the drills and milling machines can be dusted with guns which are attached by Schroder quick-acting connectors to the compressed air lines. The total horse-power of the motors installed in this part of the factory is 311.

From the first floor machine shop the magnets are passed to a heat treatment section on the second floor of the adjacent building where automatically controlled electric furnaces with a total loading of 130 kW are installed. These furnaces are arranged so that a wide range of sizes and shapes of magnets can be dealt with, while the time-cycles and temperatures of the gas furnaces, which are available as well, can also be centrally controlled. The magnetisers which are installed in this shop for the directional (Alcomax) magnets can be used either horizontally or vertically and are energised by rectified alternating current. The magnets are then returned for final grinding, testing, spray painting and packing to the top floor of the new factory, where the chucks and other magnetic tools are also assembled and dowelled after magnetic testing.

In the gauging, inspection and testing section on this floor each operator, as will be seen from Fig. 2, is provided with an individual bench, all of which are wired to accommodate a demagnetiser or testing equipment and are provided with a supply of compressed air, the latter being used for cleaning purposes. Gauging is accomplished by specially designed ambidextrous gauges, which allow checking to be carried out with an easy sequence of action.

The equipment in the finishing shop includes water-wash booths for paint-spraying preparatory to stoving, a line assembly for the magnetic chucks with overhead lifting gear and power operated screw drivers and magnetisers for the heavy-duty permanent magnet chucks and for the radial focalisers used in television. All this equipment is supplied from the busbars on the floor below through rectifiers to give the necessary direct current. A surge transformer, developed in conjunction with Burnand and Company, Limited, Sheffield, is employed for magnetising the magnets on a single copper bar. There are also special facilities for the plastic bonding of soft iron and steel pole pieces to alloys. The testing arrangements are based on telephone relay practice to speed up and assist the accuracy of the processes and to provide automatic counting.

The permanent magnets made by the firm are produced in a wide variety of materials for use in electrical meters and measuring instruments, radio and television sets, radar equipment, magnetic separators, filters and mining lamps and railway signalling relays. Other magnetic products are rectangular and circular chucks, magnetic bases for dial gauges, magnetic holders and links, chuck blocks, adaptor plates and demagnetisers. Fishing magnets for oil wells and other bore holes with lifting capacities up to well over a ton are also manufactured.

* * *

FINANCIAL HELP FOR TECHNICAL STUDENTS

The Frederick D. Edwards Scholarship Trust has been formed to assist young men and women who desire training in science and technology, but cannot afford the loss of current earnings or find themselves unable to pay tuition fees and other expenses. Mr. F. D. Edwards, who is the managing director of Edwards High Vacuum, Limited, makes it clear in the trust deed that the trustees will be free to accord help in any way they think fit. There will be no rigid limit as to persons and the capital and income of the fund (amounting to £12,000) should be spent within ten years.

Enquiries and applications for grants should be made through college principals to Mr. F. S. B. Murrells, Tresco, Nevill-court, Tunbridge Wells, Kent, or to Mr. A. J. Philpot, Cranley, Bressey-grove, London, E.18.

* * *

OPEN DAYS AT STEEL RESEARCH LABORATORIES

The British Iron and Steel Research Association, 11 Park-lane, London W.1, are holding two " Open Days " at their Sheffield Laboratories on Thursday and Friday, September 6 and 7, for representatives of member firms.

Primarily, the open days will provide the opportunity for demonstrating the progress made by the mechanical-working, steelmaking and metallurgy (general) divisions since the laboratories were inaugurated in November, 1953.

The premises will be open from 10 a.m. until 5 p.m. and luncheon and afternoon tea will be provided for visitors. Invitation cards and further details will be issued in the near future.

Book Reviews

TEACHING THEORY OF MACHINES

Theory of Machines. By W. G. GREEN. *Blackie and Son, Limited, 17 Stanhope-street, Glasgow, C.4.* (40*s.*)

This book leaves its reviewer in a quandary; the excellence of its production and its cheapness for its size, the excellence of the introductory chapters on mechanics and again the chapters on gyroscopic motion and lubrication, make him feel that this is the book which he will recommend to his students, whatever its other faults. Then, however, doubts start to arise. All the topics needed for the stultifying syllabus of the University of London External Degree examination are treated, but no attempt has been made to show how these may be linked by a common approach, or to suggest that they are anything but a collection of odds and ends.

The fundamental trouble with this book is that it sets out to treat three different subjects, mechanics, kinematics and what in the German-speaking world is known as "Maschinenelemente," without apparently realising that there is a large field of literature on the subject of kinematics which makes the approach given here look silly (indeed, the section on conditions for necessary and sufficient restraint is wrong[1]). Nor, when treating of the elements of machines and of their theory, does the author bring out clearly that the feature common to all designs, whether of cams, gears, mechanisms, or anything else, is to reduce to a minimum unwanted forces due to unwanted accelerations. The level of mathematical ability demanded is uneven, and entirely insufficient weight has been given to the powerfulness of drawing-board methods, and, in particular, to vectorial methods, in the solution of vibration problems, whether steady state or transient.

While the author treats of mechanics, his work is entirely admirable and his presentation of the essentials is lucid and clear; but it is a serious reflection on the teaching of engineering that these chapters should be needed, and, to a certain extent, it represents a reflection on the Ministry of Education which encourages the setting and taking of papers in the Ordinary and Advanced Certificates of Education in mechanical drawing, instead of insisting that boys at school should stick to experimental and theoretical mechanics.

Even if, however, the author has failed to see the wood for the trees, he has inspected, individually, a remarkably large number of the trees in this particularly murky wood; although sometimes he is mistaken in what he sees. Thus he claims that his treatment of belt friction and cams is developed without reference to existing theory and that the treatment is substantially new. It would be interesting to know what is new in the chapter on cams, and it would be wiser to leave out most of what is new in the chapter on belt friction. The theoretical refinements of treatment bear little relation to reality when no reference is made either to the fact that belts are rarely perfectly flexible or to the fact that they are usually in a state of transverse vibration, or that pulleys are usually barrel shaped and that Poisson's ratio has its part to play.

When dealing with the kinetics of machines the author pays tribute to Reuleaux, but fails to notice that, before the publication of his book, Cayley[2] and Roberts[3] had published papers which provide the starting point for modern treatments of the mechanisms derived for the 4-bar chain. They both showed that a 4-bar linkage can be devised to trace a curve through any six points (hence the approximate straight line mechanisms) and Roberts produced the theorem (for which he is famous in Germany) that, in general, there are three different 4-bar chains which all produce the same curve.

The chapter on gearing pays far too much attention to B.S. gearing systems, and far too little to fundamentals, possibly partly because (except in the sections on vibrating beams) machine parts are normally treated as being rigid.

The chapter on governors, however, is enough to make any teacher despair who wishes to educate men to understand the first principles of automatic control. Page after page is devoted to setting up the equations of motion of governors which would never have been invented had their originators read and understood Clerk Maxwell's paper of 1868, yet at no point is the equation of motion for an engine and governor set up, let alone solved. Presumably this is to be attributed to a fear of the difficulties of solving the resulting third and higher order equations, despite the fact that electrical engineering students in the first year are happily solving the same problems graphically. Surely, at a time when automation is worrying even the layman, we can offer young engineers something better than this.

There is much else to worry the user in this book, but there is also much to please. In particular, any teacher will be glad of the well-selected questions at the end of each chapter, and of the fact that answers are provided, not to mention the large number of worked examples in the text. The teacher should add this book to his collection; it is probably the last of its type. A new school of thought in the teaching of the theory of machines is already starting to produce a better type of book in the United States.

REFERENCES

[1] See Macmillan, R. H., "The Freedom of Linkages," *Math. Gazette*, vol. XXXIV, No. 307, page 26 (1950), or Rosenauer and Willis, *Kinematics of Mechanisms*.

[2] Cayley, A., "On Three Bar Motion," *Proc. Lond. Math. Soc.*, Vol. 7 (1876), p. 136—166.

[3] Roberts, S., "On Three Bar Motion in Plane Space," *Proc. Lond. Math. Soc.*, Vol. 7 (1875), p. 14—23 (see also vol. 9, p. 27).

TROUBLE-FREE DIESEL ENGINES

Petroleum and Its Combustion in Diesel Engines. By J. LAMB, O.B.E. *Charles Griffin and Company, Limited, 42 Drury-lane, London, W.C.2.* (26*s.*)

Continuing difficulty in the maintenance of adequate coal supplies to our industry and transport has thrown the spotlight on oil as a fuel with almost limitless possibilities. So great is the present demand in Britain for all grades of oil, particularly the lighter cuts, that fractions which formerly would have been regarded as fit only for burning under industrial boilers are now quite commonly used for other heating purposes and as fuel for certain types of engines. But the wider use of these heavier residual fuels in Diesel engines has posed a number of ticklish problems to the engine designers, manufacturers and operators who have had to seek and find the answers. For this reason, a book such as *Petroleum and Its Combustion in Diesel Engines*, dealing with the practical side of the problems, is to be welcomed as a valuable contribution to existing literature on the subject.

Quite a large amount of material, some of it highly technical, has been written about the design aspects of Diesel engines and, naturally, proper attention has been paid to those features of design which are particularly affected by the fuel used. So far, however, little seems to have been said about the equally important subject of the operation and maintenance of Diesel engines, especially when burning the cheaper but more difficult fractions. This omission is well met by Mr. Lamb's book, which might well be described as a "manual" for those, particularly marine engineers, who have to spend their working lives supervising the day-to-day running of Diesel engines.

The author is a man of many years' experience in the use of oil for ship propulsion, and he makes it clear that he is writing mainly for the sea-going engineer. To such, the necessity for maintaining optimum performance is obvious—no ship at sea, with its limited supplies of fuel, can afford to waste oil, nor can a marine engineer call in a manufacturer's expert if his engines break down in the middle of the Atlantic. At all costs, he must ensure continuous and trouble-free operation and, in achieving this aim, the book at present under review offers him much useful and practical advice. As Mr. Lamb says in his preface, "while operating engineers must have a general knowledge of that branch of science which deals with the conversion of heat into mechanical energy, the information most valuable to them is that which enables irregularities in the combustion process to be readily diagnosed, and which assists in determining the manner by which such faults can be remedied in the shortest time."

Starting from fundamentals, the author devotes the first part of his book to a description of the physical properties of liquid fuels and to an account of the production, processing and characteristics of petroleum. In these early pages he establishes the basic facts which form an essential introduction to combustion in general and to the combustion of oil in Diesel engines in particular, both of which subjects are considered in the following section. Certain parts of the process of introducing and burning the fuel are primarily matters of design but others come within the control of the engine operator, and emphasis is laid upon the importance of the correct adjustment of the degree of atomisation of the fuel, its penetration and the turbulence of its distribution. Another essential for the efficient use of heavy residual fuel is the maintenance of reasonably low viscosity in the feed and its freedom from solid material. If trouble-free operation is desired, both considerations must receive close and continued attention. This is made abundantly clear in the chapters which describe the methods and apparatus used for purifying oil and for preserving free-flowing characteristics.

Although it has been normal to use comparatively low-speed engines for ship propulsion, while high-speed sets have been employed mainly for auxiliary power supplies, the author foresees a wider use of moderately high-speed engines for propulsion in years to come and suggests that an installation comprising two or more such engines driving the propeller through reduction gearing has much to commend it. He explains fully how the use of residual fuels affects the operation of both low and high-speed engines, and, in his concluding chapters, gives a number of useful hints and practical suggestions for the maintenance of optimum performance. Careful maintenance is, in fact, repeatedly underlined as the key to successful operation, especially when residual fuels are employed. Well-illustrated with photographs and diagrams and presented in easy-to-read, non-technical language, Mr. Lamb's book deserves a place, especially on the shelf—restricted though it may be—of the engineer afloat.

FLEXIBLE POWER

Electric Motors and Controls. Electricity and Productivity Series No. 3. *British Electrical Development Association, 2 Savoy-hill, London, W.C.2.* (8*s.* 6*d.*)

The variety of operations that can now be carried out by electric motors in conjunction with control gear has become enormous. The volume under review describes in simple language the various types of motor that are obtainable and the methods of controlling each type.

With hand control the operator can vary the working conditions by experience to suit whatever process is involved, but with automatic control, now being developed as never before,

the machine itself chooses its operating speeds to suit the conditions. Electric motors are particularly suited to automatic control and the Electrical Development Association have well brought out these advantages in their descriptions of typical plant. One example quoted, where there has been greatly increased efficiency by using electric drives in conjunction with electronic control, is taken from a steel works. Whereas, at one time, a hydraulic system and gear mechanisms were applied to the shear equipment used for cutting off lengths of hot strip, this operation is now carried out by electric motors which can deal with any shock loads that occur and can keep the cut lengths consistent to within ½ in. of the requirement, even when the speed of production is 800 to 1,400 ft. per minute and the lengths cut range from 12 ft. to 22 ft. The book is moderately priced and gives a clear picture of what can be done with present-day equipment.

★ ★ ★

NEW BOOKS

Some of the books noticed here are selected for extended review in ENGINEERING.

The Ultimate-Load Theory Applied to the Design of Reinforced and Prestressed Concrete Frames. By A. L. L. BAKER. *Concrete Publications Limited*, 14 *Dartmouth-street, London, S.W.*1. (18*s.*)

Professor A. L. L. Baker's contributions to the Institutions of Civil and Structural Engineers, and to other professional bodies, on the ultimate-load theory for reinforced and prestressed concrete structures have been published in book form in time to anticipate the expected introduction of the use of such methods into the Codes of Practice for Concrete, now under revision both in the United States and in Great Britain. The book discusses the probability of failure and its effects, and describes how suitable factors of safety can be selected. The conception of plastic hinges enables full use to be made of the economies that are possible with the ultimate-load method of design, and is discussed at length in this book.

The Care and Use of Lifting Appliances. National Coal Board (Production) Codes and Rules. *National Coal Board, Production Department, Hobart House, Grosvenor-place, London, S.W.*1. (2*s.*)

This pamphlet is one of the series of N.C.B. (Production) Codes and Rules. It sets out the National Coal Board's rules and statutory provisions governing the use and maintenance of lifting tackle and machines. A system of classification is included, while identification and marking, inspections, testing, heat treatment, storage, and applications are also dealt with.

Television Engineering: Principles and Practice. Vol. II. By S. W. AMOS and D. C. BIRKINSHAW. *Iliffe and Sons, Limited, Dorset House, Stamford-street, London, S.E.*1. (35*s.*)

This is the second volume of a text-book on television engineering which has been written by members of the Engineering Division of the British Broadcasting Corporation for the instruction of that body's staff. It describes the fundamental principles of video-frequency amplifiers and examines the factors which limit their performance at the extremes of the pass band. A wide variety of circuits is also described, particular attention being paid to the use of feedback. There is a section dealing with the special problems of camera-head amplifiers. The treatment has a mathematical bias.

Conference on Foundry Ventilation and Dust Control, Harrogate, April, 1955. *The British Cast Iron Research Association, Alvechurch, Birmingham.* (60*s.*)

This book of 257 pages and 264 illustrations constitutes a report of the papers presented at the Harrogate conference and the discussions to which they gave rise. It contains a detailed account of the formation and dispersal of dust, and methods for its elimination or control in foundry operations.

The usefulness of the book is enhanced by the fact that the ventilation clauses of the Iron and Steel Foundry Regulations (1953) became effective on January 1, 1956. Moreover, much of the work described is also of direct interest to ventilation and consulting engineers.

Electricity in the Textile Industries. By W. E. SWALE. *The National Trade Press, Limited, Tower House, Southampton-street, Strand, London, W.C.*2. (30*s.*)

The author's purpose in this book is to write in simple language for those in the textile industry who use and pay for electricity. More importance is attached to economic factors than to technical details, but generation and distribution, motors and their control equipment, meters and power-factor correction are all dealt with. Other chapters discuss such questions as private and public supply, tariffs, safety regulations, and Continental and overseas practice. Descriptions are also given of the applications of the electric drive to spinning, weaving and finishing processes, and there are chapters on heating, ventilating and air conditioning, mechanical handling, and static eliminators.

Surveying for Civil Engineers. By PHILIP KISSAM. *McGraw-Hill Book Company, Incorporated*, 330 *West* 42*nd-street, New York* 36, *N.Y., U.S.A.* (8.50 dols.); and *McGraw-Hill Publishing Company, Limited*, 95 *Farringdon-street, London, E.C.*4. (64*s.*)

With the growing need for more and more extensive surveys in the under-developed territories there has been a considerable increase in the publication of text-books on surveying. The approach of Professor Kissam differs from the majority of other authors in this field, in as much as it considers the cost of undertaking large-scale surveys and the choice of method and instrument that, in any given case, will be likely to provide "the greatest topographic coverage and the best accuracies at a minimum cost." Although written for the practising engineer, the arrangement is suitable for a text-book to accompany university class lectures in the subject, though, as it will be appreciated, the text is based on American codes and practices.

Design of Reinforced Concrete. By BORIS W. BOGUSLAVSKY. *The Macmillan Company*, 60 *Fifth-avenue, New York* 11, *N.Y., U.S.A.* (6 dols.); and *The Macmillan Company* (*New York*), 10 *South Audley-street, London, W.*1. (42*s.*)

It was the author's intention to cater for the needs of both the student and practising engineer when compiling this book and, to this end, the text is a straightforward discussion of drawing office problems met in the calculation of reinforced concrete structures, including the design of prestressed members which is dismissed in a single chapter. The book conforms with the Building Code Requirements for reinforced concrete as adopted by the American Concrete Institute in 1951. A number of specific design problems are considered and the author claims to have included several empirical formulae (for slab dimensions, footings) and a two-cycle moment distribution method which have not previously received adequate recognition.

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TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given though distribution is sometimes restricted.

Flame Planing. HANCOCK & CO. (ENGINEERS), LTD., Progress-way, Croydon, Surrey. The "Hancoplane" flame planing machine, which will cut all four sides of an "as-rolled" plate simultaneously, and the "Hancoplane Junior," which will cut four sides at one setting, but in three operations. Both machines have three-burner compound heads, which can be set for various types of plate edge preparation. The "Junior" model will take plates up to 10 ft. wide, and is adaptable for plate-splitting. The larger machine will accommodate plates up to 11 ft. wide. Illustrated brochure.

Hydro-Electric Generators. ALLGEMEINEN ELEKTRICITÄTS GESELLSCHAFT, Berlin. Technical details of the various types of generators manufactured by them for coupling to hydraulic turbines. Illustrations of a 50 MVA horizontal machine, which is connected to a network in the Central Alps, and of a 45 MVA vertical shaft machine, which has been designed for easy assembly and dismantling. In each case, the illustrations include a general view of the machine as well as cut-away views of the various parts, all of which are numbered to facilitate identification. Illustrated brochure.

Electrical Components. VARLEY MAGNET CO. LTD. (proprietors, Oliver Pell Control Ltd.), Cambridge-row, Woolwich, London, S.E.18. Electrical coils, transformers, solenoids, electromagnets, magnetic clutches, lifting magnets, magnetising equipment, motor and vibrator assemblies. Also relays, contactors, timers, etc., of Besson and Robinson, Ltd.; and transformers (oil or air cooled up to 1,000 kVA), totally-enclosed and geared motors of $\frac{1}{20}$ to 7 h.p. of the Nelson Engineering Co. Ltd. Illustrated brochure.

Optical Diffractometer. R. B. PULLIN & CO., LTD., Phoenix Works, Great West Road, Brentford, Middlesex. Optical instrument to enable diffraction effects to be observed and studied with large objects. Its most important use is in connection with X-ray diffraction problems; but it has other applications, including the demonstration of experiments in physical optics to students. Illustrated pamphlet.

Electronic Precision Thermostat. FIELDEN ELECTRONICS, LTD., Paston-road, Wythenshawe, Manchester. Electronic precision thermostat designed for controlling temperature where long-term calibration accuracy is essential. An alternating voltage is applied to a bridge and the out-of-balance voltage is amplified by a high gain phase sensitive amplifier the output from which operates a relay. Illustrated leaflet.

Oil-Filled Cable Installations. PIRELLI-GENERAL CABLE WORKS, LTD., Southampton and Eastleigh. The oil-filled cable system. Methods of manufacture and testing. Design and performance of cables for 33 kV, 66 kV and 132 kV circuits as well as for higher voltages. Accessories. Installation conditions. Full technical details for all classes of cable, in tabular form. Data of installations at home and abroad. Illustrated booklet.

Electric Motors, Generators and Associated Equipment. THE INDUSTRIAL ELECTRICAL CO. LTD., Offord-road, London, N.1. Modern, new and reconditioned direct-current motors and generators; single-phase 50 cycle motors; squirrel cage and slip-ring motors; variable speed commutator and flameproof motors; starters and control gear; and exhaust fans. By various manufacturers. Illustrated price list.

Fractional Horse-Power Motors. HIGGS MOTORS, Witton, Birmingham 6. New range of drip-proof or totally-enclosed fractional horse-power motors for 50-cycle circuits. Standardised dimensions complying with B.S.2048. All usual voltages. Continuously rated. Three-phase and single-phase (split phase and capacitor start). Illustrated leaflet.

"Photography at Work." KODAK LTD., Industrial Sales Division, Kodak House, Kingsway, London, W.C.2. The many ways in which photography can be employed in office and factory. Copying of documents or drawings; micro-films for records; radio-graphs; high-speed photography; sales and advertising. Booklet illustrated in colour.

Compressors for Steel-Cored Aluminium Conductors. TATE BROS. LTD., 100 Old Shoreham-road, Portslade, Sussex. Single-ram "Minnifessor" for jointing steel-cored aluminium cables, from 0·02 to 0·175 sq. in. Time for making a dead-end clamp 2½ min. Weight 1 cwt. Dimensions 1 ft. 4 in. by 10 in. by 2 ft. 3 in.

Field Ratemeter. ERICSSON, LTD., Beeston, Nottingham. Transitorised battery-operated instrument for geological surveying and mapping, prospecting for radioactive ores and for examining mine workings. When used with a β-probe unit assay work can also be carried out. Built to withstand rough treatment.

Accident Prevention in Tipping Materials. CEMENT MAKERS' FEDERATION, 52 Grosvenor-gardens, London, S.W.1. Pamphlet showing some of the more dangerous hazards attached to tipping raw materials, top soil and waste from vehicles, and directing attention to the need to take all practical steps to prevent them.

High-Pressure Swivel-Pipe Couplings. AVICA EQUIPMENT LTD., Mark-road, Hemel Hempstead, Hertfordshire. High-pressure swivel-pipe couplings, or rotary joints, for rigid piping systems. Designed for 4,000 lb. per sq. in. hydraulic systems. Technical details and specifications. Illustrated brochure.

Photo-Electric Equipment. LONDEX LTD., 207 Anerley-road, London, S.E.20. Photo-electric equipment for protection and control. Projectors, receivers, counters. Visible and infra-red light. Examples of use and descriptions of standard models. Leaflet.

Staircase Time Switch. VENNER LTD., Kingston By-Pass, New Malden, Surrey. Time switch enabling staircase lighting to be switched on automatically from a central point and switched off after one to five minutes. Details of design. Illustrated leaflet No. 15.

Stop Watch. VENNER LTD., Kingston By-Pass, New Malden, Surrey. Stop watch complying with Electricity Supply (Meters) Act, 1936, for meter testing and other applications. Constructional details. Illustrated leaflet No. 56.

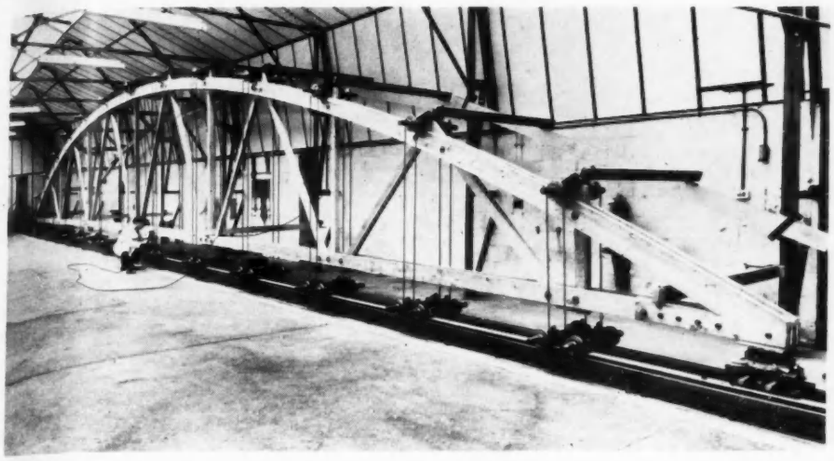


Fig. 1 An 80 ft. span bowstring girder under test. Small-scale girders are to be tested to see whether the diagonals can be eliminated.

RESEARCH FOR TIMBER DESIGN

NEW LABORATORY FOR THE T.D.A.

During the past few years there has been a considerable resurgence in the use of timber for structural purposes. To further still more the wider employment of timber, the trade association of the industry, the Timber Development Association—who are a non-profit making body—have established a new laboratory at Tylers Green, near Beaconsfield, Buckinghamshire. The work of the Laboratory is to be geared particularly to research projects that are specifically associated with design problems met when attempting to use timber for structures. This approach to laboratory work is complementary to that of the more fundamental approach of the Forest Products Research Laboratory of the Department of Scientific and Industrisl Research at Princes Risborough and of those university departments working on timber problems, so duplication of effort is unlikely.

ORGANISATION

To assist in the establishment and operation of the Laboratory the T.D.A. during last year accepted the offer of a grant-in-aid from the Government and the timber trade thereby joined the 40 or more other trades and industries whose research activities receive support from that source. The terms of the grant call for a minimum contribution from the trade of £28,000 per annum for three years from January 1, 1955, to which the Government is to add £14,000 per annum; further, up to a maximum of £4,000, the Government are to match by equal sums any additional sums provided by the trade. Thus the funds available for research (under the terms of the grant) are at least £42,000 and can be £50,000 per annum. The administration of these funds and the work of the research staff is the responsibility of the Research and Development Committee set up during last year by the council of the T.D.A. On this Committee the D.S.I.R. has two representatives, one of whom is the Director of the Forest Products Research Laboratory, so that a complete liaison is maintained with Princes Risborough and the proposals for work at the two Laboratories can be dovetailed.

For their laboratory at Tylers Green the Association have temporarily leased accommodation giving them a small modern office block of 3,000 sq. ft. on two storeys, a large single-storey test shed with a floor area of 6,000 sq. ft., and an acre of open ground on which small ancillary buildings can be erected and prototype structures built for loading and exposure tests. It will be appreciated that much of the growth in the use of timber stems from the satisfactory development of laminated glued sections that have enabled efficient use to be made of smaller pieces of wood from which knots and other faults have been cut away; thus, simultaneously, it becomes possible to make fuller use of sawn timber, both soft and hard woods, and provide a more uniform product. It is to the end of exploring the potentialities of laminated timber that much of the work of the laboratory is to be directed, though the continued use of timber as cut is not, of course, to be ignored.

During the past week the Laboratory has had its first Open Days when it has been possible for members of the trade to tour the establishment and inspect the work already being undertaken. There are four principal laboratories within the establishment: a biological laboratory which is particularly well equipped for classifying specimens and making chemical and physical tests on wood; a mechanical testing laboratory where tests of the type shown in Figs. 1 and 3 are possible; an electronics laboratory where methods of non-destructive testing are being examined; and a proving ground where larger prototypes of structures can be built and loaded to destruction. Also to be seen were a display of models, a standard preservation tank in the course of construction, and a film from the United States showing the successful approach of a commercial enterprise to the increasing demand for timber structures, including large industrial factories and bridges of considerable size.

LOAD-CAPACITY TESTS

In the mechanical testing laboratory the principal test under way was that on an 80ft. span bowstring girder, shown in Fig. 1. Both the top and bottom chords are laminated using a urea-formaldehyde type of resin adhesive. The designed live load for the truss is 300 lb. per ft. run of the top chord, giving a gross loading of about 12 tons. Altogether such a truss requires about 60 cub. ft. of timber (Canadian Douglas fir was used in this instance) and the bolted joints were all strengthened by the incorporation of 2½ in. diameter split-ring connectors. The arrangement for loading, using two continuous wire cables running over pulleys at the panel points, can be followed from Fig. 1. The capacity of the test rig is 4 tons (neglecting losses due to friction) at each panel point or a total loading of 52 tons, rather more than four times the design load. As time goes on it is intended to include some form of load measuring device, such as proving rings, at each loading point so that a more precise knowledge of the actual loading is obtained. At present, strain measurements are being made using " Demac " mechanical gauges; these demountable mechanical gauges, which employ a lever and dial gauge mechanism and with which it is possible to make approaching 200 strain measurements per hour with errors of less than $\pm 5 \times 10^{-6}$ under laboratory conditions, were described in ENGINEERING, page 791, vol. 177 (1954). Use is also being made of non-destructive electronic methods for investigating the strain properties of the timber under load.

MODEL PROBLEMS

One of the immediate objectives of the Laboratory is to determine the most economic range of span suitable for timber trusses and to this end, as well as for a more general study of the load-carrying capacity of timber trusses, a number of ¼-scale frames are being made. This scale—3 in. to the foot—was chosen as being the smallest which is thought likely not to introduce difficulties due to the necessarily fixed size of grain and thickness of the glue line. Even at this scale, however, it has been found that high standards of joinery are required because while a $\frac{1}{16}$ in. tolerance may be permissible on the length of a member for a full-scale structure it becomes of considerable significance in the model.

This last remark is particularly applicable to the ¼-scale model, depicted in Fig. 2, of an 80 ft. by 35 ft. grid vault roof which is to be tested in the proving ground. This roof is made up of 105 full panels and 10 half panels, or make-up panels, each of which consists of a prefabricated rectangular statically-determinate panel. The

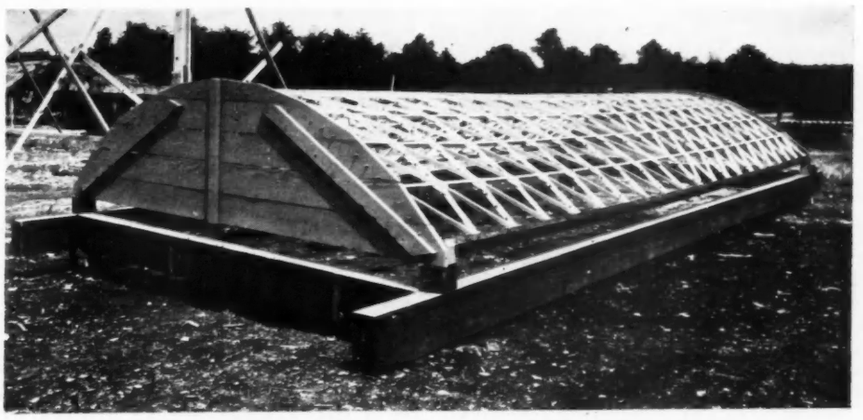


Fig. 2 A quarter-scale grid vault roof made up from prefabricated plane frames. The form of construction would appear to be a very economical proposition.

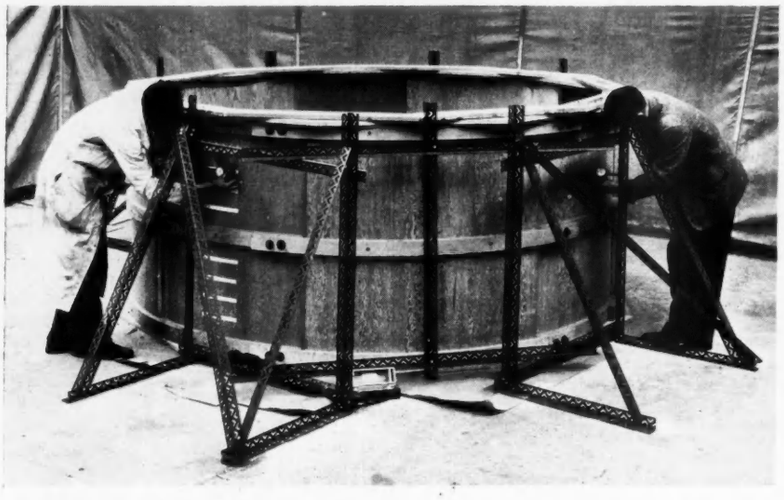


Fig. 3 Strain and distortion measurements are being made to determine the behaviour of plywood silos. The loading is being generated by filling with loose grain and surcharging with weighed sacks of grain.

Fig. 4 Dutch barn under construction. The Laboratory is seeking a design combining adequate strength, easy construction and low cost.

panels are bolted together, both transversely and longitudinally, and successive rows of panels have their joints staggered by one half panel.

In the full-scale structure each panel would be 8 ft. long by 4 ft. wide and be built up from 4 in. by 1½ in. timbers for all parts except the diagonals which would be 4 in. by 2 in. The gusset plates, which are glued into slots cut into the frames, would be of ⅜ in. plywood and the panels bolted together with ¾ in. or ½ in. bolts. The model has been constructed to test the method of fabrication, which was found to be quite satisfactory and likely to be most economical at full scale—it would only weigh about 5 lb. or 6 lb. per sq. ft. including covering—and the model will later be subjected to loading tests. Single panels will also be tested to compare their behaviour with that of the whole roof.

TIMBER BOX BEAM

Among the other principal tests already underway is a bending test, using a 30 ton Avery machine, on a plywood box beam of 20 ft. span. The beam, which is 16 in. deep by 5 in. wide, is made from Douglas fir plywood with flanges of redwood and with plywood stiffeners. Both mechanical gauges and electrical resistance strain gauges are being used and, apart from determining the load capacity of such beams—which are very economical to make—the object of the test is to study the effect of the spacing of the diaphragms and stiffeners. The beam is supported at the two ends and the centre load is divided through a series of distributor beams to four points disposed symmetrically two on each side of the centre line. In this way it has been possible to investigate three shear conditions (maximum shear, equal to the support reaction at the ends; half the maximum between two of the load points; and zero shear over the centre section of the beam) and so determine the contribution of differing diaphragm spacings and a change in wall thickness of the girder.

Two other loading tests deserve specific mention. One is on a section of a prototype plywood grain silo using contained grain and an additional surcharge of sacked grain. The illustration, Fig. 3, shows the subsidiary framing which is being used to support deflection and strain-measuring gear. The other test is on a 25 ft. laminated-timber lamp standard which is being subject to combined bending and torsion tests in order to simulate the loading that it might experience due to wind effects on a lantern carried at the end of a rigid arm.

On the proving ground, in addition to the vault grid roof already mentioned, a number of structures are under test, including a new design of a rigid-frame construction for a Dutch barn. One of the immediate objectives of the Laboratory is to find an optimum design for such barn structures which will be simultaneously sufficiently strong, easily erected by a small unskilled labour force and cheap. The latest form of the structure is shown in Fig. 4 in the course of erection; since the photograph was taken and in time for the Open Days, straining cables were fitted so that the frame can be studied for wind effects. Each bay of the barn comprises two softwood frames, 30 ft. wide and 18 ft. to the eaves. The pitch of the roof is 20 deg. and the roof covering is of curved and straight asbestos-cement sheeting. The structure is designed so that all the timber used may be of a quality and sizes that are readily available; no long lengths or large sections are necessary. The bases of the columns have been pressure treated with a waterborne wood preservative and embedded in concrete.

Another framing on the proving ground comprised three laminated arches of 30 ft. span and 12 ft. 6 in. to the crown of the arch; each is made from 11 laminates of Canadian Douglas fir and has a section of 9½ in. by 5 in. The roof and sheeting consists of tongue and grooved boards of Western red cedar. Ultrasonic equipment is being used to check the occurrence of delamination in the arches due to the combined effect of weathering and normal sustained loading.

PRESERVATION TESTS

A substantial part of the work of the Laboratory is concerned with preservatives and finishes, and two of the exhibits demonstrated this aspect of the work. One comprised the prefabricated fencing panels that surround part of the grounds, and the panels have been fixed to the posts by brackets which allow them to be easily removed for examination. The timber is half-round Sitka spruce from thinnings cut from the plantations belonging to the Forestry Commission who are co-operating on this particular investigation, and scrub oak and birch. Two kinds of preservative have been used: pentachlorophenol and monochlornaphthalene, both in fuel oil; the method of application was by cold soaking for 24 hours, followed by air drying.

The principal weathering test, which is designed to determine the effectiveness of a number of types of clear surface finishes on different kinds of wood, is being repeated at Tylers Green (country air, more-or-less unpolluted), at the T.D.A.'s headquarters in London and on Brighton pier. The specimens are mounted in racks and include samples of idigbo, sapele, red meranti, oak and Western red cedar; the types of finish include linseed oil, alkyd resin, urea and phenol formaldehyde resins and epoxy resin. Complementary tests are also being carried out in Poole harbour and at Shoreham where the effects of heavy sea action against pier structures and sea-defence works respectively are being examined.

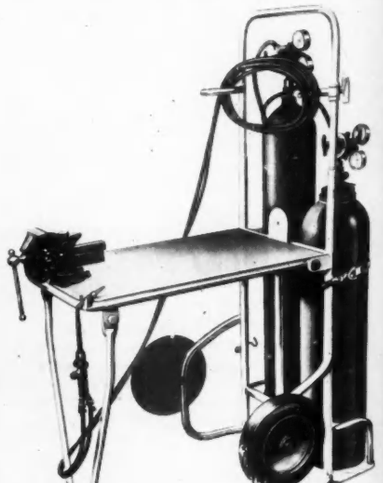
* * *

MOBILE WELDING BENCH

The "Dual" welding trolley, which is illustrated below, has been designed by Croftshaw (Engineers), Limited, 523 Ordnance-road, Enfield Lock, Middlesex. As will be seen it comprises a 3 ft. by 2 ft. bench with a combined fitter's and pipe vice at one end and a rack for carrying the oxygen and acetylene cylinders at the other. The complete assembly thus forms a compact and mobile unit, which is easy to handle and simple to erect in the factory or out of doors.

The trolley is built up of tubular steel, while the bench top is of steel plate. The bench can be locked in the operating position shown in the illustration, while the gas cylinders are secured by adjustable steel straps, which are fitted with tensioning devices.

The trolley is provided with two 14 in. pneumatic-tyred wheels, which are positioned so as to afford maximum ease of movement.



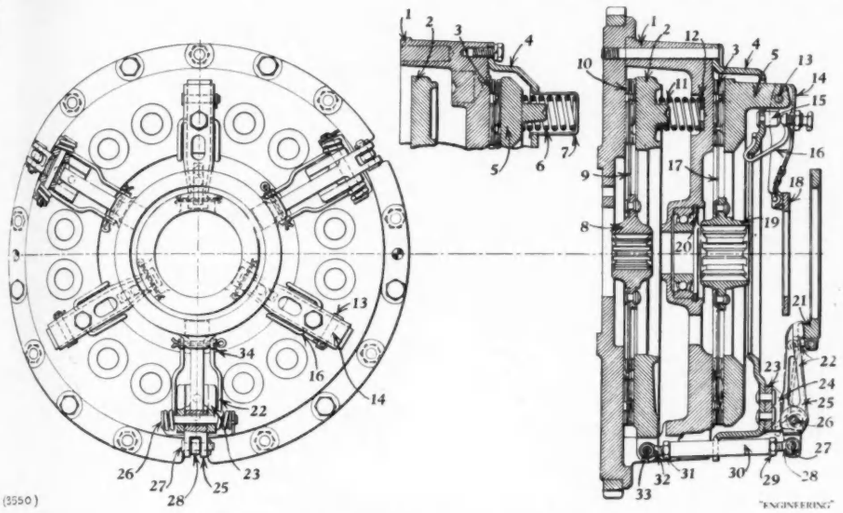
Mobile welding bench in working position showing gas cylinders and vice.

CLUTCH AND POWER TAKE-OFF

COMBINED UNIT NOW AVAILABLE FOR TRACTORS

It was announced earlier this year that the "Universal" tractor of the Nuffield organisation is now available with a combined clutch and power take-off unit which can in many cases dispense with the need for a separate engine on an implement. The Borg and Beck clutch used is shown in section in the illustration. It is, in effect, two separate clutches mounted in tandem; the inner clutch (the one nearer to the flywheel) transmits the main drive to the road wheels while the outer clutch drives the power-take-off shaft.

The double clutch is built as one unit and bolted to the flywheel in the normal way. Each clutch incorporates a pressure plate, which in the torque transmitting condition, is clamped (by means of springs) against a rigid crimped type driven plate fitted with normal friction facings. The drive from the engine is disconnected from the main transmission or the power take-off by releasing the appropriate pressure plate from its driven plate.



The double clutch unit that can now be fitted to some tractors gives full control of both drive and power take-off, together or independently.

The clutches are actuated by independent throw-out forks in conjunction with ball thrust bearings. The tractor transmission clutch is operated externally by an orthodox clutch pedal, and the power take-off clutch by a hand control lever situated on the nearside, convenient to the operator's left hand. Power from the tractor main drive clutch is transmitted by a solid splined shaft to the primary shaft of the gearbox; while the drive from the power take-off clutch is by hollow splined shaft to flanged dog couplings, and thence to a hollow spur pinion driving a gear secured to an intermediate power take-off shaft which runs to the rear of the tractor and has the usual splined end for connection.

POWER TAKE-OFF CLUTCH

The power-take-off clutch is built up from a pressed steel cover (4), a pressure plate (5), twelve thrust springs (6) carried in cups (7), and a driven plate consisting of a splined hub (19) to which is riveted a disc (17) carrying two friction facings (3); the splines in the driven plate hub engage splines on the power take-off shaft. The power take-off cover is attached to the main drive cover (1) by six set screws secured by spring washers.

Three lugs on the pressure plate (5) pass through slots in the cover (4) and to each of these a release lever (14) is pivoted by means of a pin (13); the lugs also serve to transmit the drive from the cover to the pressure plate. Each release lever has a retaining spring riveted to its inner end and also carries an adjusting screw; the inner ends of the levers are shaped to provide a location for the forked lugs of a release lever plate (18) which is retained by split pins fitted behind the retainer springs. Three further springs (16), which engage holes in the sides of the release levers and also hook behind the cover, ensure that the adjusting screws are always in contact with the seats (15); these latter parts act as fulcrum points for the release levers.

MAIN-DRIVE CLUTCH

The main-drive clutch consists of the following: the cast cover (1), a pressure plate (2), twelve thrust springs (11) which seat against heat insulating washers (12), and a driven plate consisting of a splined hub (8) to which is riveted a disc (9) carrying two friction facings (10); the splines in the driven plate hub engage splines on the main drive shaft. This shaft passes through the centre of the hollow power take-off shaft and runs to the main gearbox. A grease-packed ball bearing (34) to carry the end of the power take-off shaft is housed in a recess formed in the centre of the cover and is retained by a Circlip (20).

The pressure plate (2) is connected, by means of three turnbuckles (30), to the outer ends of three release levers (25) each of which is mounted within a yoke (23) and bushed to carry a headed pivot pin (26). At the release lever end, each turnbuckle carries a left-hand threaded eye bolt (28) which is connected by means of a headed pin (27); at the other end a right-hand threaded eye bolt (32) is carried and is connected to a forked lug on the pressure plate by means of a plain pin (33); in this way the movement of the release levers is transmitted to the pressure plate. The lugs on the pressure plate engage slots in the main-drive cover, thus providing the required drive.

A release lever plate (21) is retained against the inner tips of the three release levers by springs (22), one end of each spring being connected to the plate by means of a split pin while the other ends are secured by the pivot pins (26).

PRINCIPLE OF OPERATION

As has already been stated, this unit incorporates two clutches in one assembly, the inner clutch being used for the main drive while the outer is for the power take-off. With both clutches engaged, as illustrated, the thrust springs (11) are clamping the inner driven plate between the flywheel and the pressure plate (2), while the other thrust springs (6) are clamping the outer driven plate between the main-drive cover (1) and the pressure plate (5); the engine torque is therefore transmitted to, and shared by, the main-drive shaft and the power-take-off shaft. To obtain the transmission of maximum engine torque from the main-drive clutch, the power take-off clutch must be disengaged, and vice versa.

To disengage the main drive, the outer release lever plate (21) is moved towards the flywheel, which is thereby made to depress the inner tips of the release levers (25); the levers pivot about the pins (26) causing the turnbuckles (30) to displace the pressure plate (2) nearer to the gearbox against the load of the thrust springs (11), thus releasing the clamping pressure from the driven plate facings (10) and disconnecting the main drive from the engine.

To disengage the power take-off the inner release lever plate (18) is moved towards the flywheel, pushing the inner tips of the release levers (14) with it; the adjusting screws and seats (15) acting as fulcrum points about which the levers pivot. Hence, the resultant movement of the outer ends of the release levers causes the pressure plate (5) to be displaced nearer to the gearbox, against the load of the thrust springs (6). In this way the clamping pressure is released from the driven plate facings (3) and the power take-off is disconnected from the engine.

Some of the advantages claimed for this unit are that (as mentioned earlier) separate engines on implements such as combines and balers can be dispensed with; the tractor can be halted while the implement is still working to allow the latter to clear a bad patch or free a jam; and the tractor can be manoeuvred independently of the implement operation, that is to say, stopping, starting and gear changing can be carried out without interruption of the power take-off. Equally, full control of the power take-off can be maintained with the tractor stationary.

* * *

MODEL CONTRACT FORMS

Two new Model Forms of General Conditions of Contract have been prepared by the Joint Committee on Model Forms of General Conditions of Contract of the Institutions of Mechanical and Electrical Engineers. One of these is for use in connection with export contracts with delivery f.o.b. or c.i.f.; and the other for the sale of electrical and mechanical goods, other than electric cables (home without erection). The first form supersedes one issued in 1928 by the Institution of Electrical Engineers.

The users of these Model Forms are warned that it must not "be assumed that in a given series the various Forms will differ only in so far as the type of contract to which they refer makes necessary, and that 'standard clauses' will necessarily remain the same throughout the series."

The price of the first form is 4*s.* 6*d.* and of the second 2*s.* 6*d.*, in both cases including postage. They can be obtained from the Institution of Electrical Engineers, the Institution of Mechanical Engineers and the Association of Consulting Engineers.

* * *

TWIST DRILLS FROM STOCK

New premises at Garrett's Green Lane, Birmingham, 33, which have been built by Monks and Crane, Limited, to provide improved accommodation for their head office, showroom and warehouse, were officially opened during last month. At these premises the Company hold large stocks of twist drills, taps and dies, milling cutters, reamers and saw blades. They have also added to the goods stocked the range of coated abrasives made by the Minnesota Mining and Manufacturing Company, Limited.

ELECTROSTATIC PAINTING OF WASHING MACHINES

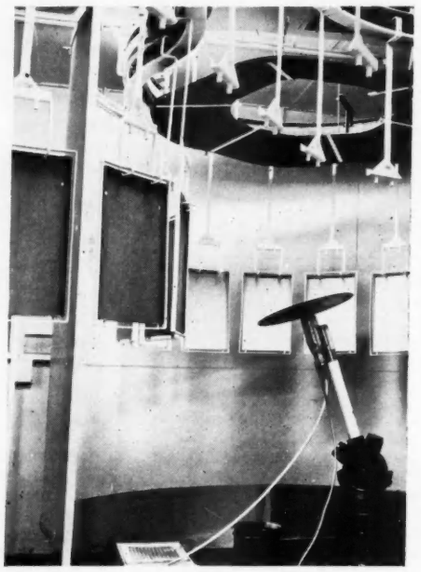
Paint Consumption Halved, Productivity Doubled

At their Merthyr Tydfil factory, Hoover (Washing Machines) Limited, have recently installed Ransburg electrostatic painting plant and electric infra-red stoving ovens for the application and stoving of both primer and enamel on certain of their washing-machine components. As a result of this installation, paint consumption has been halved, productivity per operator doubled and a more consistent result attained.

The components are brought by conveyor in turn to the primer and enamel sections, each of which consists of a glass-sided spraying booth, flash-off chamber (where the solvent evaporates) and infra-red stoving oven. The methods of applying paints are different in each but the principle is the same. No air pressure is used, the paint being delivered by gear pumps to rotating spraying heads where it is atomised by the high potential of 90,000 volts existing between the negative spraying head and the work which is at earth potential. So fine is the atomisation that only a very faint mist can be seen during painting. Through the glass of the spraying booth the component is seen progressively and evenly acquiring its coat of paint as the paint is attracted to the components of opposite polarity.

In each of the spraying booths there are two heads, one for painting the back of the work, the other for the front. The primer coat is applied by two inclined rotating discs around which the work passes on 3 ft. radius loops in the conveyor. After flash-off the paint is stoved for 5½ minutes in an electric infra-red oven. The components then go by conveyor to the enamel spraying booth, where the enamel is supplied through two sets of " bells," each set being called a " triple-head." After flashing-off the paint is stoved for 7 minutes in another infra-red oven, thus completing the process.

The Ransburg electrostatic equipment was supplied by Henry Peabody (Industrial), Limited, 17 Great Suffolk-street, London, E.C.1; and the infra-red heating equipment by Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester.



Interior of the primer-spraying compartment of the electrostatic paint plant recently installed at Hoover's Merthyr Tydfil factory. The primer coat is applied by two rotating discs forming the negative electrodes, charged at 90,000 volts. The work itself is at earth potential.

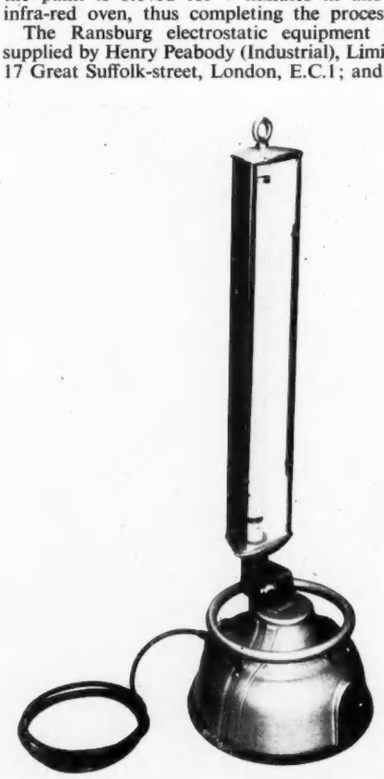
* * *

PORTABLE FLUORESCENT LIGHT FOR MAINTENANCE WORK

A portable fluorescent light unit for inspection and overhaul work has been introduced by Engineering Developments (England), Limited Mark-road, Hemel Hempstead, Hertfordshire.

The EDM103 fluorescent light unit as it is called can be adjusted to throw a concentrated shadow-free light in any direction. The light source which is a 2 ft. 40 watt fluorescent tube working on 230 or 240 volt mains, can be swivelled through 180 deg. and the reflector can be tilted at any angle. In the horizontal position the light is only 10 in. from the ground, so that it can be slipped under vehicles or other objects and the reflector placed, if required, to throw the light directly upwards. The overall height of the unit with the light in a vertical position is 3 ft. 6 in.

So that electric tools can be connected directly to the unit, a power take-off socket is provided in the base, which in addition contains all necessary control gear. The makers describe the unit as being exceptionally strong, and well able to stand up to the handling it can be expected to receive in garages and engineering workshops.



This shadow-free 40 watt fluorescent lamp can be swivelled through 180 deg. and the reflector can be tilted at any angle. Electric tools can be plugged into the base.

MAKING DIRTY WATER DISPOSABLE

Waste from Washing Aircraft

At certain airports, it is the practice to wash aircraft with detergent preparations containing thinning oils and dispersing agents. This results in the production of waste waters containing as much as 8 per cent. of emulsified oil and having a permanganate value of the order of 1,400 p.p.m. A treatment plant has been developed to deal with these waters and is described in the report of the Water Pollution Research Board for the year 1955. The plant is a simplified version of the one that has been installed to deal with cutting-oil waste and floor washings in a large aero-engine factory and was described in detail in an article which appeared in ENGINEERING, vol. 163, pages 513 and 537 (1947).

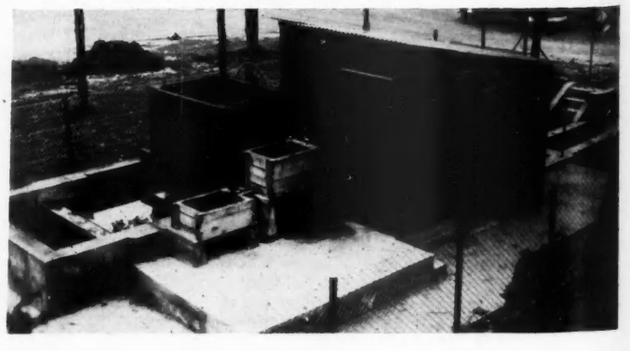
BREAKING DOWN EMULSIONS

Emulsions of the type to be dealt with can be broken by relatively large concentrations of aluminium sulphate and sulphuric acid and these materials are used in the factory plant referred to. For the aircraft washing waters, concentrations of at least 4,000 p.p.m. were found necessary. Treatment with reagents at concentration of this order reduced the permanganate p.p.m. value of 1,408 of the original emulsion to a p.p.m. value of 130 after treatment and sedimentation for 20 hours. The *p*H value of the treated liquid was 1·9. Acid alone or common salt are also effective for breaking the emulsion. Aluminium, ferric or calcium salts can be used but result in the formation of very bulky precipitates unless the *p*H value is reduced to about 2·6. This is probably due to the detergent preparation containing a considerable amount of phosphate.

Common salt has been selected as the reagent for the airport plant. This has the advantages of simplicity of operation, the avoidance of the use of strong acid and the fact that no precipitate of solid matter is formed. Test figures for common salt treatment show a permanganate value of 1,408 p.p.m. for the original emulsion, one of 131 p.p.m. after treatment and sedimentation for 20 hours and a *p*H value of the treated liquid of 9. The effluent is oil-free and very saline but suitable provision has been made for its discharge.

GRIT AND FLOATING OIL

The plant is illustrated below. On the extreme right is the inlet channel in which grit and floating oil can be separated from the emulsion. The main structure is the pump house and chemical stores and to its left are the reagent solution tanks, the larger one for common salt and the smaller for aluminium sulphate for use if required. The treatment tank, in which the emulsion is broken by the addition of the chemical reagent, is below. Oil separated in this tank is drawn, or floated, over the sloping ramp of the weir into the collecting pit on the extreme left and the aqueous layer is discharged slowly to the sewer through a submerged outlet. Relatively large quantities of common salt are required but this is justified by the simplicity and convenience of the plant.



Plant for treating waste water after use for washing aircraft.

The Machine Tool Industry (*continued from page* 91)

Although in many machine tools the general principles of design have remained unaltered for a considerable period, minor improvements continue to be made; marking and engraving machines, which are discussed below, fall mainly into this category. The second article this week in our series on the machine tool industry deals with broaching machines, which, with the assimilation of automatic techniques, seem to be taking an increasingly important part in manufacturing processes. In previous articles in the series we have been concerned with: automatic control systems, machining light alloys, spark erosion, welding equipment, drilling, boring and milling, turning, screwing and threading, cutting fluids and slideway lubricants, furnaces and heaters, woodworking machinery, sawing, and grinding and surface finishing.

MARKING AND ENGRAVING

Excluding hand engraving and chemical etching, neither of which is dealt with here, there are five principal methods of marking the sort of article—generally, though not always, of metal—with which engineers are concerned. The required marks can be punched or pressed into the surface, engraved into the surface by some form of cutting tool, etched into the surface by a minute electric arc, shot blasted, or marked or printed on the surface with some type of paint or pigment.

PRESSURE MARKING

Pressure marking is the logical development of the letter, figure or symbol punch held in the hand and struck with a hammer, but it is, of course, capable of much greater speeds and more consistent results. Interchangeable metal type, together with special marks and symbols made to order, and automatic numerators for marking serial numbers, can be set up and impressed into the surface to be marked in various ways. For simpler and lighter work, where speed of output is not important, there are hand or foot operated machines, where the manual power is assisted by means of a toggle mechanism. Heavier work, or work which is to be carried out at high speed, requires the addition of mechanical, pneumatic or hydraulic power. This type of marking equipment is easily adapted for quantity production; it can, for example, be used in a conveyor line for marking long narrow articles such as tubes or bar stock. Methods of mechanical feeding for work of different shapes can also be devised.

MARKING FLYWHEELS

An example of a heavy-duty pressure marking machine designed for quantity production is illustrated in Fig. 1. Made by Funditor, Limited, 3 Woodbridge-street, London, E.C.1, who also produce a range of other pressure-type marking machines. The machine illustrated is for marking and graduating automobile flywheels. It is equally suitable for dealing with large pipe flanges and any other components of similar shape. The article to be marked is carried on a sliding table, and revolves while the marking pressure is applied hydraulically. The machine may be adjusted to suit the diameters of different articles.

MACHINE ENGRAVING

Perhaps the most versatile of all the engraving machines is that which moves a small rotating cutting tool over the surface of the article to be engraved, the path of the tool being controlled, through a pantograph, from a stylus tracing metal copy letters, figures or designs. The stylus is guided manually by the operator, who also controls the depth of cut. A range of machines of this type is made by Taylor, Taylor and Hobson, Limited, Stoughton-street, Leicester. The pantograph arrangement is such that the proportion between the copy and the actual engraving can be varied at will, and a single set of copy letters can be made to serve for numerous sizes of engraved work. A typical standard machine has pantograph reductions ranging between 2 to 1 and 16 to 1, and pantographs can be supplied to work between the limits of 1 to 1 and 1 to 6.

A very common type of work for pantograph engraving machines is the engraving of numbers, words and symbols on nameplates or components, which may be flat or of any other shape, but the machines are capable of many other types of work as well. For example, flat sheet metal shapes, which are required in numbers too large for making by hand, but too small to warrant press tool making, can be produced on the pantograph machine by cutting right through the metal to the required profile. Similarly, other materials such as plastics, can be cut out for display purposes. Simple dies for pressing this sheet metal or for plastic moulding can also be produced; the patterns can include, besides words, figures and symbols, designs such as fancy borders.

THREE-DIMENSIONAL ENGRAVING

In the normal form of pantograph engraving machine the height of the tool is regulated by the operator, and a certain amount of vertical adjustment is provided to allow the tool to be raised clear of the work and to cut into it to the required depth. Separate adjustment is provided to accommodate workpieces of different shapes and thicknesses. If, however, an additional joint is provided in the pantograph to permit vertical movement of the tool under the

Fig. 3 Pantograph machines can engrave by means of minute electric arcs. They are often fitted with multiple heads; this machine has 15. (Taylor, Taylor and Hobson, Ltd.)

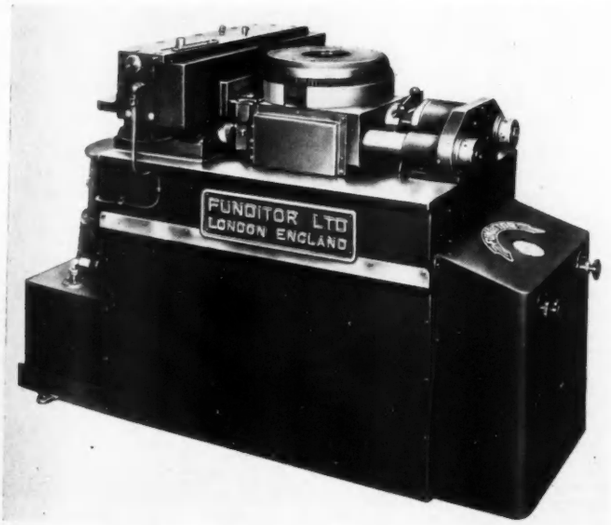


Fig. 1 Marking of automobile flywheels and objects of similar shape is carried out by this heavy-duty pressure marking machine designed for quantity production. (Funditor, Ltd.)

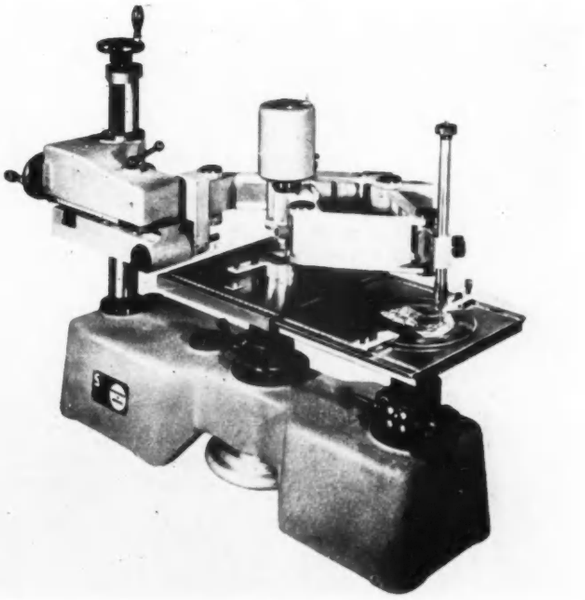


Fig. 2 The French Scripta pantograph engraving machine can be arranged for three-dimensional work. The surface contours of the master are reproduced to a pre-determined scale. (Acbars, Ltd.)

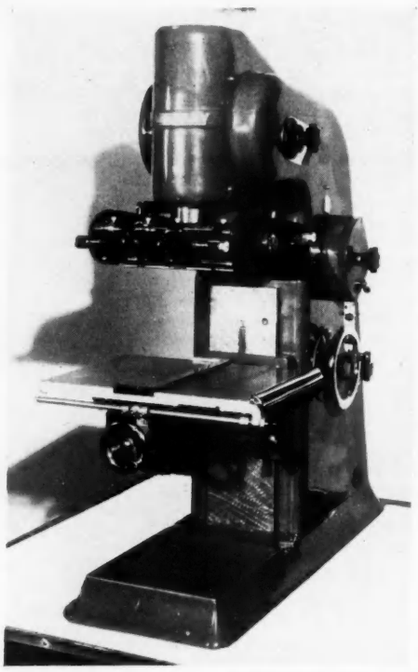


Fig. 4 Marking at very high speed is possible on this machine, through the medium of heat and pressure and coloured foil. (Masson Seeley and Co. Ltd.)

control of the stylus or guide finger, then the machine becomes capable of three-dimensional work.

Such machines were exhibited by Taylor, Taylor and Hobson, Limited, and by Acbars, Limited, 57a Holborn Viaduct, London, E.C.1. A French Scripta machine, shown by the latter firm, is illustrated in Fig. 2. It will be seen that the copy (in this case a die for a medal), and the engraving are mounted on horizontal tables, over which the pantograph is suspended from a column at the rear. The complete pantograph can be raised and lowered on the column by means of the handwheel at the top to bring it to the required working height. The engraving tool is driven directly by the motor mounted above it, and its movements reproduce, to the scale set on the pantograph, the surface contours of the master, which can be seen on the right-hand table in the illustration on page 119.

ELECTRIC ETCHING

A variant of the rotating-tool type of pantograph engraving machine is the electric etcher, made by Taylor, Taylor and Hobson, Limited. This carries, in place of the tool, a miniature electrode. As the electrode holder moves across the surface of the article to be marked, under the control of a pantograph and copy, the electrode is caused, by means of a tuned reed and an electro-magnetic circuit, to vibrate up and down into and out of contact with the work surface.

The number of vibration cycles depends upon the current characteristics (it is 100 times per second on a 50 cycle supply), but the speed is always high, and the result is that a rapid succession of minute arcs is struck between the electrode and the work. This close succession of arcs forms a clean line of uniform width following the path set by the copy.

Machines operating on a principle of this kind are particularly suitable for the high-speed marking of ground or polished articles, and will work perfectly sactisfactorily on hardened steel; they can therefore be used on such components as ball races or gauges. They are usually provided with multiple heads, to carry out marking of several workpieces simultaneously. A Taylor, Taylor and Hobson 15 head "Javelin" electric etcher is illustrated in Fig. 3, on the previous page.

There are certain materials and components which cannot, for one reason or another, be marked by impression or cutting tool. Cemented carbides, for example, because of their hardness, glass and ceramics, because of their brittleness, and some engineering components where relatively deep markings might act as stress-raisers; all these require special treatment. Some of these items can be marked by electric etching, which is so light as to produce virtually negligible damage.

SHOT-BLAST MARKING

There is, however, a further form of marking machine which is ideal for all the purposes mentioned, and has numerous other uses as well. This is the shot-blast machine, as was exhibited by Funditor, Limited. Marking in this machine is done by means of fine grit blown under air pressure against the surface of the article to be marked, a special mask being interposed between the grit jet and the workpiece to direct the grit, as with a stencil, into the pattern required. The mark is permanent, but the force applied to the surface of the workpiece is negligible, and thin-walled articles such as radio valves can be marked without difficulty or risk of damage.

PIGMENT MARKING

Still another method of marking is that employing pigments and interchangeable type and dies. Machines of this type are included in the range exhibited by Masson Seeley and Company, Limited, 14 Howick-place, London, S.W.1, and one of them is illustrated in Fig. 4. This machine operates by means of heat and pressure applied through type and dies, and pigmented foil coloured as required. It can be fully automatic in operation, and articles ranging from paper thickness to 17 in. high can be accommodated. The controls are grouped on one side for convenience in operation, and they can be set to give the required speed, pressure and type of run, the latter being single stroke, continuous operation by foot pedal or hand control, or continuous automatic operation. Speeds up to 6,000 markings per hour are possible, depending upon the type of marking and the article being marked.

The Machine Tool Industry

BROACHING MACHINES

"Broaching machines," said a man at the Machine Tool Exhibition, "can do anything that a milling machine can do—and quicker." Whether or not this is true—and the continued manufacture of milling machines in manifold variety would tend to dispute it—the broaching machine has in recent years become very adaptable, and the development of multiple broaches, automatic and semi-automatic cycles, continuous chain operation, automatic lubrication, swarf removal, feed and ejection, copy broaching, automatic work stabilising devices, and broach retrieving mechanisms has made the broaching tool a versatile high-speed production unit. Since the previous exhibition there has also been a trend towards simplicity, and, as with other tools, there is a general tendency, too, for cutting speeds to increase. In fact, according to our confidante, the day when surface broaching will be carried out at speeds up to 200 ft. per minute is not far distant, though this immensely exceeds those in current use. Broaching machines are normally classified in terms of their action, whether they are designed for push or pull, up or down, internal or external (surface) operation, and whether the broach—or the work—travels in a vertical or horizontal direction. In the present article, however, these distinctions will only be mentioned incidentally, and in describing some of the machines exhibited, we shall concentrate primarily on the manner in which the various special features referred to above have been embodied in their design.

PRODUCTION-LINE BROACHING

The underlying theme of the articles in this series is the use of automatic techniques, and it is fitting that we should deal first with this aspect in discussing broaching machines. Fig. 1 shows an XM "Cyclematic" vertical broaching machine, made by Weatherley Oilgear, Limited, Biggleswade, Bedfordshire, in which the workpieces are pulled upwards over stationary broaches. The machine is built for heavy-duty mass-production conditions and, being automatic in operation, is suitable for flow-line production. It may be tooled, for example, to finish broach the bores of generators and starter housings for the automotive industry and has three broaches to which rough housings can be fed by three conveyor chutes, leading from another machine in the process. The automatic cycle proceeds whether all three broaches are cutting or only one or two, and one operator can patrol the complete production line of which the broach is a part.

Several sizes of this machine are made, including the XM 30 × 54, the XM 50 × 66, the XM 75 × 66 and the XM 80 × 54 — in each case the first figure refers to the broaching capacity in thousands of pounds and the second to the maximum length of stroke in inches. Some idea of the range can be obtained from the output of the largest of these machines set up for broaching the housings previously mentioned. The normal pulling force is 80,000 lb. with a peak of 115,000 lb. and the stroke, which is adjustable by push-button, may be varied from 26 in. to 54 in.; broaches of any length from 32 in. to 55 in. can be fitted. For a bore about 4 in. in diameter, and a permitted tolerance of 0·004 in., the best broaching speed is 25 ft. per minute, and approximately 0·06 in. of steel is removed in the operation. The complete cycle time is 25 seconds, but this might be less if the

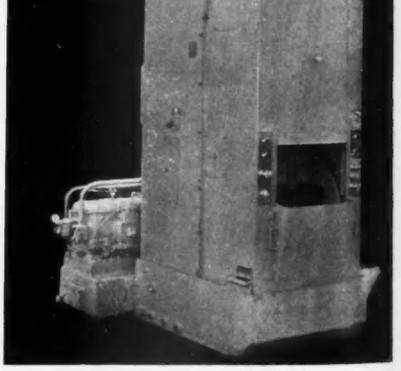
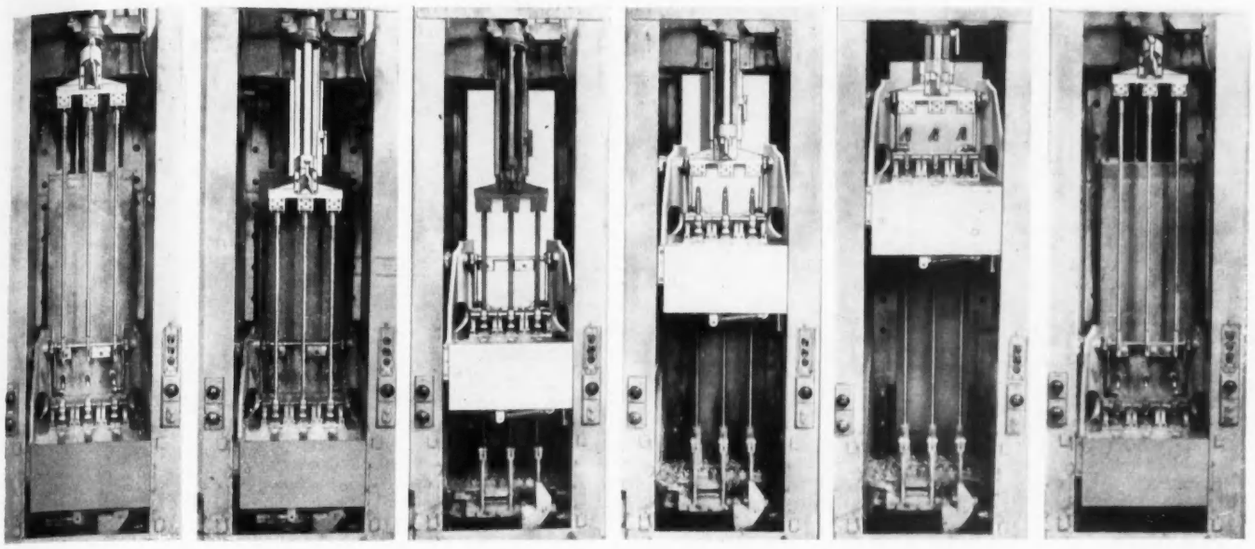


Fig. 1 In the XM "Cyclematic" broaching machine a complete work cycle from feed to ejection can be carried out without intervention of the operator. (Weatherley Oilgear Limited.)



(a) (b) (c) (d) (e) (f)

Fig. 2 The Weatherley Oilgear XM vertical internal pull broaching machine employs the "Cyclematic" principle, which enables the machine to be used for flow-line production. The operations in the automatic cycle are: (a) loading, (b) engagement, (c) broaching, (d) disengagement, (e) ejection, and (f) return.

stroke were reduced. The makers claim that with the machine working at full efficiency starter housings have been broached at the rate of 432 per hour.

All movements of the machine are adjustable for speed and can be pre-set to suit the given component. This adjustment is effected by a set of pump controls which govern four solenoid-operated pilot valves, so providing four independent controllable flows from a single two-way variable-delivery pump. The four circuits are responsible for controlling (1) broaching speeds, (2) broach return speeds, (3) broach handling, up and down, and (4) component magazine feed, in and out. A safety relief valve is fitted to the pump and set at a slightly higher value than the working load, so safeguarding the machine and tools should an incorrect component be delivered to the machine.

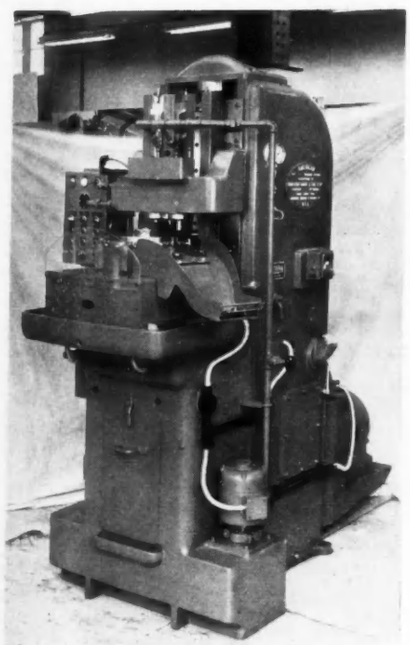


Fig. 3 The "American" vertical broaching machine built in this country by the Coventry Gauge and Tool Co. Ltd., can be arranged for automatic operation when surface broaching, by means of a hydraulically operated indexing and reciprocating table. (Rockwell Machine Tool Co. Ltd.)

AUTOMATIC CYCLE

The operation of the work cycle can be gathered from Fig. 2. Illustration (*a*) represents loading; tools are suspended from holders on the upper slide and the work is roughly centred by means of a fixture. In (*b*), the broaches engage; as dual push-buttons are depressed, the upper slide rapidly lowers the guard and tools, automatically threading and centring the work; after the shanks of the descending broaches have entered pullers on the bracket below the worktable slide, keys are engaged and cutting fluid begins to flow as the carriage and work start to move upwards. The worktable slide is pulled upwards (*c*), carrying the work over the stationary broaches, which are secured at both ends during most of the working stroke. The following operation (*e*) is ejection, in which a roll and cam ejector bar quickly moves forward to discharge the components from the fixtures on to a spring-loaded tilting plate; the ejector bar then rapidly returns, as the worktable and tool-handling slides start downwards; holders on the tool-handling slide engage the top shanks of the tools; and finally, as the worktable slide nears the loading position, the plate carrying the broached parts is tilted and the work slides automatically from the machine by way of a chute. The last movement in the cycle (*f*) is the return to the loading position; the worktable slide descends automatically, under controlled rapid traverse, and disengages from the pulling keys, whereupon the upper tool-handling slide automatically raises the broaches and guard; at the same time the cutting fluid is shut off for convenience in loading further workpieces. In the cycle described the operation is not entirely automatic, but it will be seen that with the addition of feed chutes and a slight change in the controls so that push-button starting is unnecessary, flow-line production could be achieved.

Other features of the XM machines include automatic pressure lubrication of tools and workpieces during broaching, an assisted broach-removal mechanism operated by a switch, chain-conveyor swarf disposal and safety controls. For flow-line operation a component feeding magazine can be fitted.

THREE-DUTY MACHINE

Another unit that can be equipped for automatic cycle operation is the "American" broaching machine, designed by the American Broach and Machine Company, made in this country by the Coventry Gauge and Tool Company, Limited, and exhibited at Olympia by the Rockwell Machine Tool Company, Limited, Welsh Harp, Edgware-road, London, N.W.2. Fig. 3 shows one version of the machine—arranged to surface broach valve rocker arms—

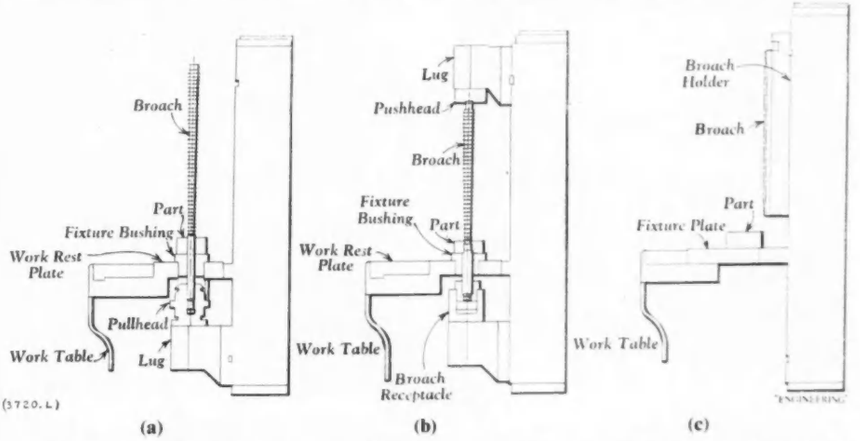


Fig. 4 The "American" broaching machine (Fig. 3) can be arranged for (a) pull, (b) push, or (c) surface broaching, and also for keyway, multiple and combination broaching.

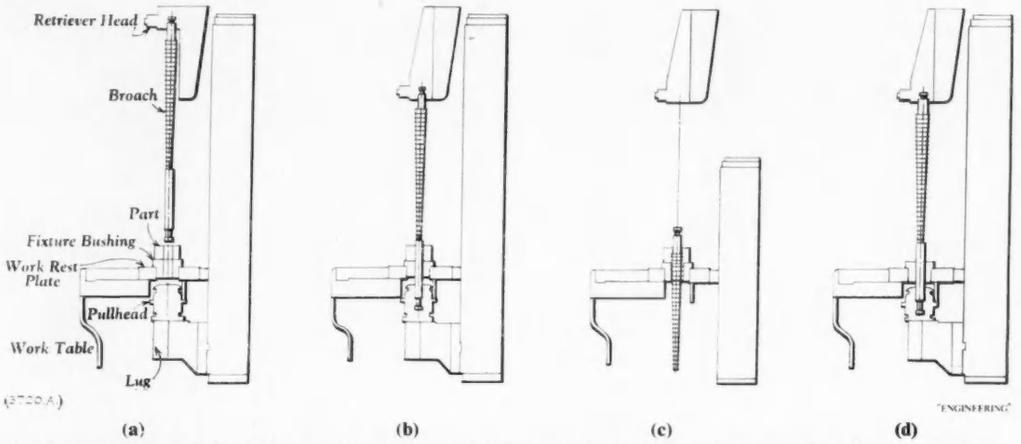


Fig. 5 Conversion of the "American" machine (Fig. 3) to semi-automatic operation can be effected by addition of a broach-retrieving unit. Sequence: (a) broach suspended in retriever head—retriever slide starts to descend; (b) release by retriever head and beginning of broaching stroke; (c) end of broaching stroke—workpiece removed; and (d) machine slide returns broach, which is gripped by retriever head and released by pull head, ready for next cycle.

which operates on an automatic cycle with a reciprocating and indexing table. Three components are broached at once and the table rotates to bring three more components into position, while the previous set moves round for automatic unloading; the reciprocating motion of the table permits the withdrawal of the broaches. Control is effected by solenoid-operated valves through hydraulic manifolding which supplies power to the various motions in sequence; an Igranic control panel can be seen at the top left of the machine. In this arrangement loading is not automatic, but a magazine feed mechanism can be fitted in certain circumstances.

Possibly the most interesting feature of the machine, however, is its versatility, since it can easily be adapted for surface broaching or for push or pull down internal work. The three tooling arrangements are shown in Fig. 4. In (*a*) the head is connected to a lug mounted at the lower end of the machine slide ready for pull broaching. Conversion to push broaching can be effected by transferring the lug and the head to the upper end of the machine slide (*b*). For surface broaching the lug is removed from the machine slide and replaced by a surface broach and holder assembly (*c*).

BROACH RETRIEVING

Sometimes it is convenient in pull broaching internal bores to adapt the machine for semi-automatic operation, and this is effected in the case of the American machine by mounting a broach retriever unit on top of the column. It is manually controlled by means of a lever, and its action, which can be gathered from Fig. 5, is independent of the machine slide, so that there is no interference with any surface broach assemblies if fitted. In Fig. 5 (*a*) the machine slide is in the up position, the broach suspended in the retriever head and the work piece loaded; the operator sets the retriever slide in motion, which lowers the broach shank into the pull head. The operator then starts the broaching stroke (*b*), and the machine slide pulls the broach through the workpiece. On completion of the stroke (*c*), the workpiece is ready for removal Finally (*d*), the operator starts the return of the machine slide, which brings the broach up to the retriever, and the retriever slide travels back to the up position. The operation is semi-automatic since the operator does not handle the broach, which is automatically released from both the slide and pull head.

The "American" series of machines, which have automatic lubrication, adjustable strokes, speed control and interlocking safety devices, and may be arranged for multiple, combination or keyway broaching, are made in four sizes. The T-4-24 has normal and maximum capacities of 4 and 6 tons (9,000 and 13,500 lb.) and a maximum stroke of 24 in. The T-8-24 has the same stroke but the normal and maximum load capacities are 8 and 12 tons (18,000 and 27,000 lb.). The stroke of the T-10-36 is 36 in. and its normal and maximum capacities are 10 and 14 tons (20,000 and 31,000 lb.). The corresponding figures for the T-15-48, the largest in the range, are 48 in. and 15 and 19 tons (34,000 and 43,500 lb.); the downward broach speeds of this model are infinitely variable from 6 to 18 ft. per min. while the small machines have lower ranges: 4 to 12, 4 to 12 and 5 to 15 ft. per min., respectively.

Two features of the Weatherley Oilgear XS 30 × 66A vertical surface broaching machine which extend the scope and efficiency of the broaching process are an automatically stabilised shuttle table and provision for copy broaching. The basic version of this machine, the XS 30 × 66 (30,000 lb. pull and 66 in. stroke) is shown in Fig. 6. The XS series includes some 18 machines ranging from 6,000 lb. broaching capacity and 30 in. stroke to 120,000 lb. capacity and 96 in. stroke, with broaching speeds on certain models up to about 25 ft. per minute.

STABILISED SHUTTLE TABLE

The Weatherley "automatic stabilised" shuttle table is not only arranged to pre-load the work table against the micro stops, but also to pre-load the table in a downward direction against the knee-bracket wear plates. It is thus impossible for the worktable to move against these plates as a result of fluctuations in the

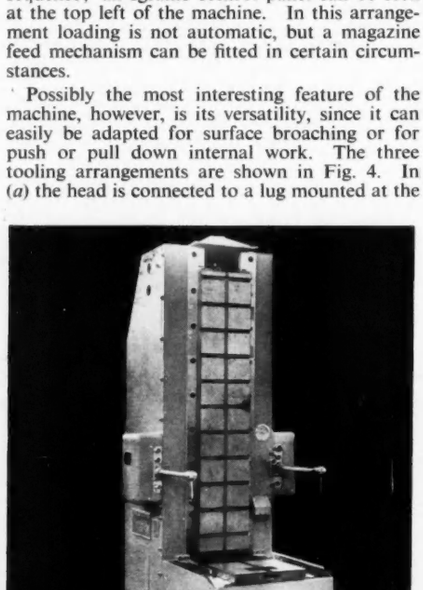


Fig. 6 The Weatherley Oilgear XS 30 × 66A vertical surface broaching machine, a variation of the XS 30 × 66 machine illustrated here, has an automatically stabilised shuttle table and provision for copy broaching.

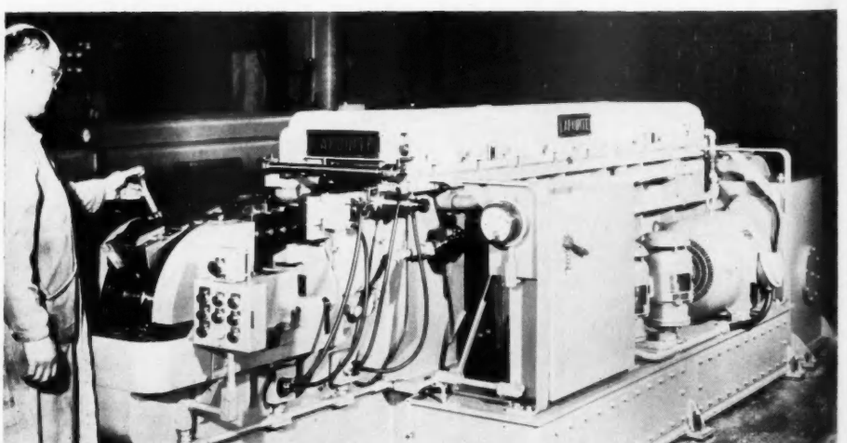


Fig. 7 In the Lapointe continuous broaching machine, a double chain carries the workpieces past stationary broaches, so that with, say, 20 component fixtures as many as 1,100 connecting rods can be side, face and half-round broached in an hour. (Lapointe Machine Tool Co. Ltd.)

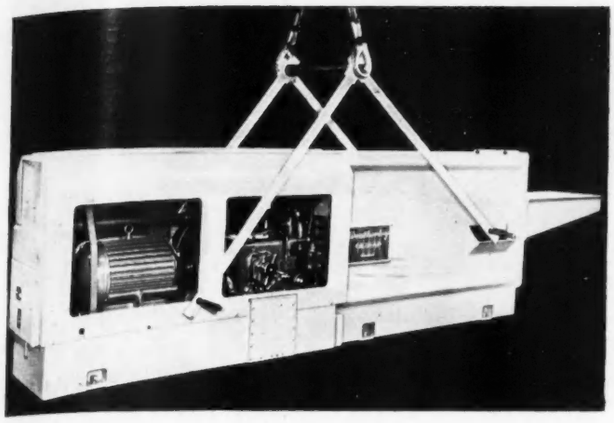


Fig. 8 XL horizontal broaching machine. Simplicity is the keynote of this machine, which can be fitted with automatic broach handling equipment and may be adapted for automatic feed and ejection. The machine is shown slung for transporting. (Weatherley Oilgear Ltd.)

broaching force. The normal shuttle-table operating gear brings the table horizontally towards the broaches, and the force applied to hold the table against the micro stops on the machine frame, including any pre-loading force, is thus applied horizontally, at right angles to the line of movement of the broaches. If the downward force applied to the workpiece during the broaching stroke were steady and uniform, there would be less difficulty in obtaining a perfect finish, but in most cases, this force rises and falls many times during each cutting stroke, and at times the sudden release of pressure tends to create a slight bounce or reaction. This reaction is made possible by the running clearance in the work table slideways—which must be about 0·001 in. to 0·0015 in. or even more—and results in slight shudder marks in the finished broach surface.

To overcome this disadvantage in the XS 30 × 66A machine, the force produced by the shuttle-table operating gear and the additional force obtained by pre-loading have been changed in direction. In the new design, the operating gear has been re-arranged to apply the force in a direction inclined downward to the horizontal, so that the table is held down by a force greater than any reaction force met in broaching. The makers claimed that every trace of shudder has been eliminated and that the machine is particularly suitable for precision broaching.

A "push back resisting" work table with runways inclined downward towards the work, which is specially useful where thin cuts (0·0005 in.) are to be made, has also been developed by the company for fitting to their XSS series of universal slab (surface) broaching machines.

COPY BROACHING

The copy broaching technique applied to the Weatherley XS 30 × 60A machine enables all kinds of uniform or non-uniform curves, profiles and contours, convex, concave or combinations of both, to be machined. In addition, a profile form may be produced in two planes simultaneously.

The essential features of the design are as follows. A cam rail is fitted to the broaching slide bar parallel with the line of broaches and is made with a working form corresponding to the curved shape required on the workpiece; moreover, its design is such as to give the most efficient sequence of cutting. The fixture carrying the workpiece consists of two main parts: a base secured to the machine table and a horizontal slide with a very short stroke to which the workpiece is attached. At the front of the work-holding slide, there is a needle roller bearing which is always in contact with the cam rail on the machine slide during broaching. At the back of the work slide, there is a hydraulic ram which applies pressure to the slide to keep the roller in contact with the cam rail.

On the down stroke of the machine slide, the cam rail moves the sliding part of the work-holding fixture in controlled relationship to the straight-line movement of the row of broaching teeth, and the teeth copy broach the workpiece to the contours on the cam rail. It should be mentioned that the broach teeth are spaced wide apart and only one tooth cuts at a time. Only the finishing cuts need to follow the desired finished contour. Several machines equipped with this tooling are in operation, mainly on concave and convex faces of fir-tree roots for gas-turbine blades.

CONTINUOUS BROACHING

One of the most novel and interesting items shown at the exhibition was a horizontal continuous broaching machine made in the United Kingdom by the Lapointe Machine Tool Company, Limited, of Otterspool, Watford, Hertfordshire. Employing a continuous double chain to carry workpieces past fixed broaches, the machine is designed for large-scale mass-production work in the automotive and other industries. The makers claim that when equipped with 6 fixtures it can produce 360 parts per hour at a cutting speed of 21 ft. per minute, and if 15 fixtures are used an output of 960 parts per hour can be obtained.

A model made by the associated American company, the 50/120 in. version, is illustrated in Fig. 7, which shows the machine broaching connecting rods, giving, with 20 fixtures, an output of 1,100 rods per hour, but production speeds as high as 1,400 automotive connecting rods per hour, broached sides, face and half round, have been reported. All models are capable of broaching flat and contoured surfaces and may be fitted with hopper feed, continuous disposal of ejected parts and conveyor chip-removal, to provide fully automatic operation.

The separate, self-locating, self-clamping and self-releasing fixtures are so designed that the operator has merely to insert the parts approximately in position; the fixture then centres the part ready for broaching. The number of fixtures can be varied and speeds altered by exchanging the pick-off gears to give values from 20 to 40 ft. per minute. The fixtures are guided during broaching through hardened and ground lateral ways. The bonnet, or broach-carrying cover, is hinged to the frame and accommodates the main broach assemblies, which are clamped directly to it.

A variety of safety features are incorporated, including shear pin couplings, which can be replaced in a few minutes, to guard against overloading, observation ports so that the operator can see the broaches in action, and devices to ensure that the components are positively located in the fixture and to stop the machine should anything interfere with normal operation. The machines are made in four standard sizes: a 10 h.p. model with 42 in. stroke, 20 h.p. with 66 in. stroke, 30 h.p. with 90 in. stroke, and 40 h.p. with 120 in. stroke, but any combination of horse-power and stroke within this range can be obtained. The Lapointe company also makes other horizontal and vertical broaching machines, many of which have recently been modified to give longer

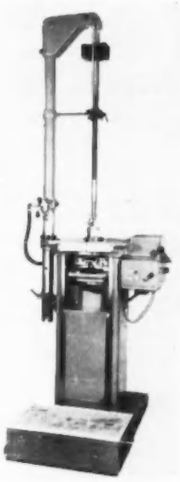


Fig. 9 Economy in manufacture, without sacrifice of accuracy, rigidity and reliability, is claimed by the makers for the Model T.7 vertical broaching machine. The stroke of the tractor bridge can be adjusted to suit broaches up to 36 in. long. (B.S.A. Tools Ltd.)

Fig. 10 Broach passing through component on the B.S.A. T.7 machine, the pulling jaws of which automatically grip and release the broach at suitable points in the cycle.

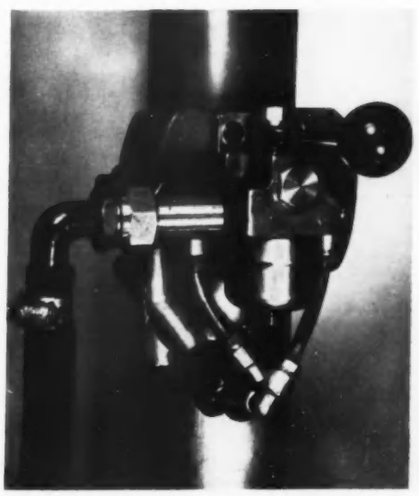


Fig. 11 Hand control for air operated hoist of retriever unit, which can be fitted to the B.S.A. T.7 machine, so permitting power-assisted handling of the broach and reducing operator fatigue.

strokes and to permit broaching of heavier work than was previously possible.

SIMPLICITY AND ECONOMY

Another horizontal machine and a vertical machine may be used to illustrate the trend towards simpler design. Fig. 8 shows the Weatherley Oilgear XL horizontal broaching machine, which can be fitted with broach-handling equipment, and automatic feed and ejection. It may be used for mass production and is designed for simplicity of maintenance. A recent development of this machine, the XLW, which was exhibited at Olympia, combines most of the features of the earlier machine but has been designed for easier fitting and assembly, so reducing manufacturing costs without sacrificing quality of materials.

A vertical broaching machine, in which emphasis has been placed on simplicity, but without loss of accuracy, rigidity or reliability, is the Model T.7, recently added to the range of machines made by B.S.A. Tools Limited, Mackadown-lane, Kitts Green, Birmingham 33, and shown on the stand of Leo C. Steinle Limited. It has been designed to enable the broaching process, both internal and external, to be employed when the high initial cost of many machines would make it prohibitive.

The machine, which can be seen in Fig. 9, and in close-up with the broach passing through a component in Fig. 10, is compact, self-contained and occupies a floor space of 31 in. by 33½ in. It comprises a combined table and gearbox unit supported on four pilars carried on a cast-iron bed plate. The vertical lead screws have journal and thrust bearings in the table unit and journal bearings in the base. Effective guarding is provided but does not limit access to the machine. The broaching load is taken by heavy-duty ball thrust races, and the arrangement of the pulling jaws is such that they automatically grip the broach, and, in addition, are automatically opened by means of an adjustable stop when the tractor bridge returns to the top position. The jaws can also be operated by a pedal. The full stroke of the tractor bridge can be adjusted to suit broaches with a cutting length of up to 36 in.

Among the attachments which may be fitted is a broach retriever unit designed to reduce operator fatigue by eliminating the need to transfer broaches manually. When the tractor bridge has returned to the reload position and the pulling jaws are released, the broach is lifted clear of the table by an air-operated hoist, the hand control for which is illustrated in Fig. 11, while the operator loads the next workpiece. The broach is then lowered until the pull end is seated in position in the tractor bridge and the machine is then started in the normal way. The lifting head of the retriever unit is so made that it positively locks on to the broach while it is lifted, but releases as soon as the broach is seated on the tractor bridge.

The Model T.7 has a pulling capacity of 7 tons and a maximum stroke of 36 in. Cutting speeds of 4, 6 and 9 ft. per minute may be selected and the constant return speed is 9·5 ft. per minute. The height of the machine is 53½ in.

ATOMIC REVIEW

Particles and Power

Neutrinos and antiprotons—Atoms photographed—Problems of controlled thermonuclear fusion—New source of neutrons?—Berkeley nuclear power station approved and tenders for another at Largs to be submitted—Soviet atomic energy journal to be translated.

Particles

Since the discovery, at the University of California last September, of the antiproton—a particle similar to a proton but electrically negative—further information on its behaviour has been given, and another particle, the neutrino, the existence of which had been postulated to reconcile inequalities in the balance of energy emitted during radioactivity—has been detected. Professor Edoardo Amaldi speaking of the antiproton at the Academy of Sciences in Rome has reported that collisions with nuclei have been observed in stacks of photographic emulsion, in which at least six charged particles were emitted with a total energy of more than 860 MeV. Since a comparable number of invisible neutral particles were almost certainly emitted simultaneously, with similar energies, the reaction is believed to be associated with the annihilation of antiprotons. Antiprotons have been produced with the 6 GeV Bevatron at the University of California.

The neutrino, which has been known by hypothesis for some 25 years, is thought to be emitted by certain radioactive atoms at the same time as electrons and to carry away some of the energy evolved; it was in fact to explain the properties of these electrons that the existence of the neutrino was originally suggested. More recently it has been shown that the neutrino has no electrical charge and that its mass is zero or negligible even in comparison with an electron. Detection has been made difficult by these properties, since direct electrical methods are excluded and since the chances of impact with some other body are slight. It has been suggested that if a million neutrinos were directed at the earth, all but one, on the average, would pass through.

However, at the Los Alamos Laboratory of the United States Atomic Energy Commission, where the discovery was made, the operation of nuclear reactors results in the release of large numbers of neutrinos, and a tank 6 ft. cube filled with a liquid scintillator has been used to detect these particles. The scintillations or small flashes of light produced were recorded by some hundred photo-multipliers. Once or twice a minute one of many million neutrinos emitted by a nearby reactor would collide with a proton in an atomic nucleus, so forming a neutron and a positron (positive electron) and producing scintillations. The occurrence of two scintillations at the same time implied the destruction of a neutrino. The scientists responsible for this work are Dr. F. Reines and Dr. C. Cowan.

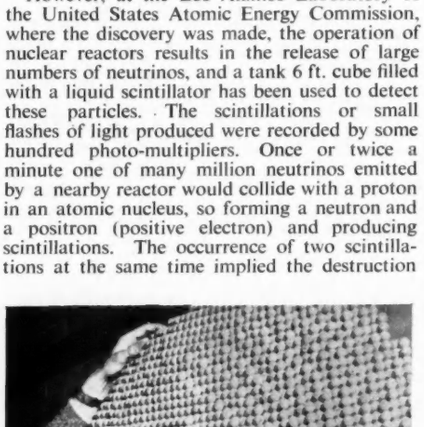


Fig. 1 Atoms are represented by small cork balls in this model, which shows how closely the theoretical atomic arrangement was repeated in the photograph (Fig. 2).

It is of related interest that at the recent conference on high-energy physics at Geneva, Professor Heisenberg said that existing theories "at best served to give a semi-phenomenological explanation for the qualities of elementary particles, but they failed to explain their existence convincingly." He announced that he and a team of German physicists at the Max Planck Institute, Göttingen, were drafting an expanded and remoulded version of the Quantum Theory. With this he hoped science could reach better conclusions "about the masses and interactions of elementary particles." There is at present a considerable need for a unified theory of particle physics.

Atoms

We reproduce on page 125 what is believed to be one of the first photographs showing atoms as separate entities: the resemblance to a corresponding atomic model built from small cork balls, illustrated in Fig. 1, is apparent. The photograph (Fig. 2) was taken by Dr. E. Muller, professor of physics at Pennsylvania State University, U.S.A., by means of a field ion microscope and presents a clear view of pearl-like atomic clusters magnified 2,750,000 times. To make the picture, the tip of a tungsten wire, so fine as to be invisible to the eye and sharpened to a point, was inserted in the microscope, the temperature of which was reduced to − 300 deg. F. by the addition of liquid nitrogen; this is being carried out in Fig. 3, which shows the apparatus comprising two vessels resembling glass Thermos flasks, one inside the other. Helium gas was used as a source of ions and the tungsten tip produced a highly magnified picture on a fluorescent screen at the base of the glass tube containg the wire. A special camera, which can be seen in Fig. 3 below the tube and slightly above the table top, photographed the screen. This technique is expected to yield useful information on chemical reactions between solids and gases.

Thermonuclear Fusion

In previous issues of ENGINEERING (vol. 181, pages 318, 322, 355 and 409; and vol. 180, page 235) we have referred to the benefits that might arise from controlling the hydrogen fusion reaction, and using it instead of or complementary to nuclear fission as a source of electric power. Some of the advantages are said to be: abundance and universality of raw materials whether light or heavy hydrogen be employed, less gamma radiation and consequently less shielding required, and no radioactive fission products. But apart from the difficulty of containing a reaction which can, it seems, only be initiated at temperatures in excess of a million deg. C., if hydrogen alone is used as fuel, we have devoted little attention to the very serious problems and disadvantages the fusion process presents. Recently the *Atomic Scientists Journal* has published a report of a talk on the subject given by Professor Hans Thirring, Director of the Institute for Theoretical Physics, Vienna. The main problem seems to be that to make the process manageable, a cyclic reaction may be involved, and in that case other expensive materials will possibly be necessary, so defeating one of the alleged advantages of the fusion system. It also appears that some controlled processes may be too slow to yield any useful output.

One cyclic process, believed to be employed in some hydrogen bombs, entails the formation of helium from deuterium and lithium 6 in a two-step reaction:

$$\alpha\text{-particle} + \text{neutron} \rightleftharpoons \text{deuteron} + \text{triton}$$

$$\text{neutron} + \text{lithium } 6 \rightleftharpoons \text{triton} + \alpha\text{-particle}$$

Deuterons and tritons are, of course, the nuclei of the hydrogen isotopes, hydrogen 2 (deuterium) and hydrogen 3 (tritium) respectively. Should this prove to be the answer, then lithium, which exists in the earth's crust in the proportion

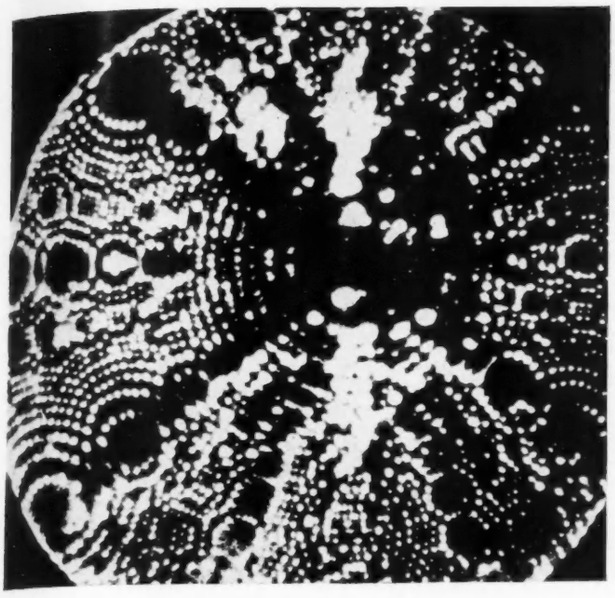
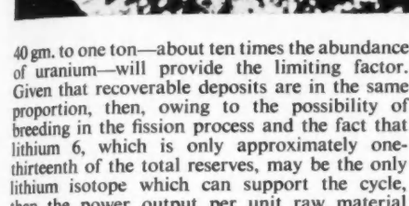


Fig. 2 Atoms appearing as separate entities have been photographed for what is believed to be the first time. The subject of the photograph was the sharpened tip of a fine tungsten wire and the magnification factor 2,750,000.

40 gm. to one ton—about ten times the abundance of uranium—will provide the limiting factor. Given that recoverable deposits are in the same proportion, then, owing to the possibility of breeding in the fission process and the fact that lithium 6, which is only approximately one-thirteenth of the total reserves, may be the only lithium isotope which can support the cycle, then the power output per unit raw material may be of about the same order as with uranium. Thus not only would there be no abundance of natural resources, but they would also not be universally distributed; America would once again have the advantage. Moreover, although helium is both harmless and useful, tritium, which can be assimilated as the oxide, super-heavy water, by living things and is lethal in minute quantities, is also formed in the process. Neutrons, too, released during the reaction, are dangerous in that they are highly penetrating particles and can make substances radioactive by bombardment. Thus a neutron reflector and thick radiation shield would still be necessary.

The so-called carbon cycle, beginning and ending at the asterisk: •



by which helium is made from hydrogen with the original carbon 12 regenerated at the end in the manner of a catalyst, is said to be the means by which energy is generated in certain stars. The products of the reaction are electrically neutral since the reacting protons are associated with electrons in the hydrogen atom; two of these are available to combine with the positrons (positive electrons) and the remaining two are embodied in the helium nucleus. The total energy evolved is about 27 MeV.

If this reaction were used for power production, a hermetically sealed vessel with a thick neutron shielding wall would be sufficient protection, since radioactive elements occur as intermediary products but no neutrons are in fact released. However, the carbon cycle is grossly inefficient, producing energy at a rate of only two ergs per second per gram of reacting substance, which is a small fraction of the specific energy output of a candle flame. This is adequate for bodies the size of the sun but hardly for industrial power production.

Another condition of satisfactory operation is that the process shall run as a self-sustaining chain reaction as does the fission process in existing reactors. In the lithium bomb—if such it is—the process is certainly fast enough to develop a chain reaction. In fission, the production of two or three neutrons at each nuclear fission and the fact that uranium 235 or plutonium fission can be caused by neutrons at very low speeds mean that a chain reaction can proceed at any reasonable temperature and that the engineering and materials problems are not overwhelming. What is more, control can be effected by inserting rods of neutron absorbing substances and owing to the negative temperature coefficient of reactivity a fission reactor is within certain limits self-stabilising. This seems to be outside the scope of any fusion reaction. True, the part of the lithium-deuterium process on the lower side of the diagrammatic cycle can be caused with slow neutrons and therefore might proceed at moderate temperatures; but no more neutrons are produced to continue the process. The upper half of the cycle in which the required neutrons are generated can only occur at many millions of degrees centigrade. At such a temperature control rods are not feasible and there is no known self-stabilising effect. A thermonuclear fuel mixture like deuterium-tritium or lithium hydride either fails to react or reacts at temperatures beyond normal means of control.

However, it is not unreasonable to suppose that the immense resources which are being devoted to research in this field will produce discoveries capable of simplifying the problem. There seems to be an almost infinite number of cycle arrangements possible with existing nuclides and perhaps by suitable choice—even of more common elements—a more convenient reaction may be discovered. As for lithium, means may be discovered of using the more abundant isotope lithium 7. It is worth noting that the Belgian Geomines company is to produce lithium regularly in a pilot plant from tailings supplied by the Manono tin mines, Belgian Congo and a plant for the Congo is under consideration. In addition, geothermal steam in New Zealand contains 10 parts per million of lithium and the Dominion laboratory has proved a technique for recovery of the metal.

Neutrons

The value of neutrons in research and especially in research into thermonuclear fusion adds interest to news of a possible new source of neutrons. It appears that spontaneous fission of the transuranic elements can provide neutrons in very much greater intensity than the radium-beryllium sources in current use. An emission of 10^{11} neutrons per second, corresponding to that provided by a 10 kg. radium source, would be obtained from 30 milligrams of californium 252. This isotope might be produced by long-term irradiation of plutonium in a high-flux reactor.

Power Programme

Following the announcement that permission had been granted for the building of a nuclear power station at Bradwell in Essex (ENGINEERING, July 20, page 92), the Central Electricity Authority have now received the consent of the Minister of Fuel and Power to the establishment of the proposed second station at Berkeley on the Severn Estuary in Gloucestershire. Like that at Bradwell, it will have turbo-generator sets with an aggregate capacity of about 200 MW and two carbon-dioxide-gas cooled graphite-moderated reactors. Proposals of the four industrial groups tendering for the two stations are due by October 1; preliminary work is already in hand and construction work should start on both sites in the New Year.

It has also been reported that tenders for a third station, near Largs on the Ayrshire coast, are to be submitted by the end of the year. Dr. H. S. Arms, project manager of the atomic power department of the English Electric Company, Limited—members of the group which also includes Babcock and Wilcox, Limited, and Taylor Woodrow, Limited—has stated that the capital cost of early atomic power stations would be about £150 per installed kilowatt as against £55 for the most efficient conventional stations. He also believed that the project on which his company was engaged would make possible the generation of electric power from nuclear sources at a cost within 10 or 15 per cent. of that for the most efficient existing stations, and better than some.

Soviet Journal

A verbatim translation of *Atomnaya Energiya*, the Soviet journal of atomic energy, is to be published as a supplement to the *Journal of Nuclear Energy*. Arrangements have been made to do so by the editors of the *Journal* and Pergamon Press, with the co-operation of the U.S.S.R. Academy of Sciences. The first translation will appear with the August issue of the *Journal*, which is to be published monthly instead of bi-monthly from now on. The first issue of *Atomnaya Energiya* contained articles on a gas-cooled heavy-water power reactor, the iodide method of zirconium refining, the acceleration of charged particles, locating uranium deposits, preparing einsteinium and fermium in a cyclotron, measurement of the thermal neutron cross-section of thorium 232, the economics of atomic power, and a variety of other subjects.

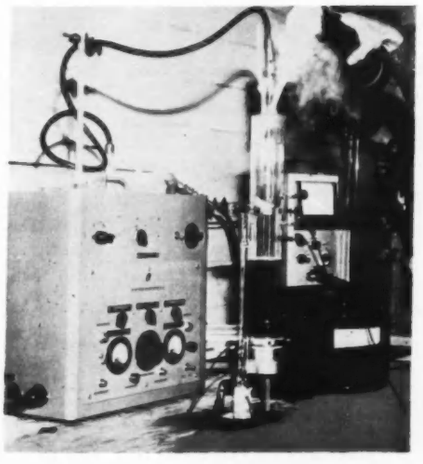


Fig. 3 To take the photograph reproduced in Fig. 2 a field ion microscope was used. Helium served as the ion source and an image of the tungsten wire thrown on a fluorescent screen was photographed. Liquid nitrogen is shown being added to reduce the temperature.

FORTHCOMING EXHIBITIONS AND CONFERENCES

This list, arranged chronologically, appears in the last issue of each month. Events appearing for the first time, and alterations of dates, places, etc., are indicated by an asterisk (*). Particulars of exhibitions and conferences not included below may have appeared in ENGINEERING, *May* 25, *page* 412; *or June* 29, *page* 574. *Organisers are invited to send to the Editor particulars of coming events as soon as arrangements are made.*

Pacific National Exhibition.—Thurs., Aug. 2, to Mon., Sept. 3 at Vancouver. Apply to Mr. Ben Williams, Exhibition Park, Vancouver, B.C., Canada.

Geographical Congress.—Thurs., Aug. 9, to Sat., Aug. 18, at Rio de Janeiro, Brazil. Apply to Mr. G. H. T. Kimble, International Geographical Union, 330 West Forty Second-street, New York 36.

***Application of Surface Active Agents in Industry, Conference on.**—Wed., Aug. 15, at Copenhagen, Denmark. Sponsored by the International Union of Pure and Applied Chemistry. Apply to Dr. Rudolf Morf, Sandoz A.G., Basle, Switzerland.

Radio and Electrical Appliances Exhibition.—Wed., Aug. 15, to Sat., Aug. 18, at Dar es Salaam. Apply to the organising secretary, Radio Exhibition of Social Development, Dar es Salaam.

X-Ray Microscopy and Microradiography, Symposium on.—Thurs., Aug. 16, to Tues., Aug. 21, at the Cavendish Laboratory, Cambridge. Held under the auspices of the International Union of Pure and Applied Physics, with financial support from U.N.E.S.C.O. Apply to the organiser, Dr. W. C. Nixon, Cavendish Laboratory, Cambridge. Tel. Cambridge 54481.

***Combustion, Sixth International Symposium on.**—Sun., Aug. 19, to Fri., Aug. 24, at Yale University, New Haven, Conn., U.S.A. Organised by the Combustion Institute, Union Trust Building, Pittsburgh 19, Penn., U.S.A. Apply to the Combustion Symposium Office, 400 Temple-street, New Haven 10, Conn., U.S.A.

Izmir International Trade Fair.—Mon., Aug. 20, to Thurs., Sept. 20. Apply to British Chamber of Commerce of Turkey, Piyasa Han 602-606, Asirefendi Cad. 11–13, Istanbul.

Mombasa Trade, Industry and Agriculture Exhibition.—Wed., Aug. 22, to Sun., Aug. 26. Organised by the Muslim Association, P.O. Box 583, Mombasa, Kenya.

Radio Show (23rd Annual National Radio and Television Exhibition).—Wed., Aug. 22, to Sat., Sept. 1, at Earl's Court, London, S.W.5. Preview for overseas and special guests, Tues., Aug. 21. Organised by the Radio Industry Council, 59 Russell-square, London, W.C.1. Tel. MUSeum 6901.

"Model Engineer" Exhibition.—Wed., Aug. 22, to Sat., Sept. 1, at the New Horticultural Hall, Greycoat-street, London, S.W.1. Organised by *The Model Engineer* (Percival Marshall & Co., Ltd.), 19-20 Noel-street, London, W.1. Tel. GERrard 8811.

Canadian National Exhibition.—Fri., Aug. 24, to Sat., Sept. 8, at Toronto. A stand illustrating the United Kingdom's post-war scientific and technical achievements is being arranged by the British Government. Examples of automation equipment will be included in this display. Apply to the Board of Trade, Horse Guards-avenue, London, S.W.1.

***Electromagnetic Phenomena in Cosmic Physics, Symposium on.**—Mon., Aug. 27, to Fri., Aug. 31, at Stockholm, Sweden. Organised by the International Astronomical Union. Apply to Professor P. Th. Oosterhoff, University Laboratory, Leyden, Holland.

***Theoretical and Applied Mathematics, Ninth International Congress on.**—Tues., Aug. 28, to Sun., Sept. 2, at Brussels. Organised by the International Union of Theoretical and Applied Mathematics, 41 Avenue de l'Arbelète, Boitsfort, Brussels, Belgium.

British Food Fair.—Tues., Aug. 28, to Sat., Sept. 15, at Olympia, London, W.14. Including exhibition of food preparing and wrapping machinery. Organised by the British Food Fair, 290 Minster House, St. James'-court, London, S.W.1. Tel. VICtoria 3674.

International Society of Soil Science, Sixth International Congress.—Wed., Aug. 29, to Sat., Sept. 8, in Paris. Organised by the International Society of Soil Science, Royal Tropical Institute, 63 Mauritskade, Amsterdam, Holland.

British Association Meeting.—Wed., Aug. 29, to Wed., Sept. 5, in Sheffield. Apply to the secretary, British Association for the Advancement of Science, Burlington House, Piccadilly, London, W.1. Tel. REGent 2109.

Pretoria Industrial Exhibition.—Fri., Aug. 31, to Sat., Sept. 8. Organised by the North Transvaal Chamber of Industries, P.O. Box 933, Pretoria.

Foundry Trades Fair, International (GIFA).—Sat., Sept. 1, to Sun., Sept. 9, at the Fair Halls, Düsseldorf. To be held in connection with the 23rd International Foundry Congress. Organised by the Nordwestdeutsche Ausstellungs-Gesellschaft m.b.H. (NOWEA), Ehrenhof 4, Düsseldorf, Germany. *Agents:* John E. Buck & Co., 47 Brewer-street, London, W.1. Tel. GERrard 7576. See ENGINEERING, October 21, 1955, page 565.

Strasbourg European Fair, 31st.—Sat., Sept. 1, to Sun., Sept. 16, at Strasbourg. *Agent:* R. C. Liebman, 178 Fleet-street, London, E.C.4. Tel. CITy 5889.

St. Erik's Fair.—Sat., Sept. 1, to Sun., Sept. 16, at Stockholm. *Agents:* Thirza West Publicity Ltd., 141 New Bond-street, London, W.1. Tel. MAYfair 3701.

Damascus International Fair.—Sat., Sept. 1, to Sun., Sept. 30, in Damascus. Including United Kingdom pavilion. Apply to British Overseas Fairs Ltd., 21 Tothill-street, London, S.W.1. Tel. WHItehall 6711.

Leipzig International Autumn Fair.—Sun., Sept. 2, to Sun., Sept. 9, Leipzig. *Agents:* Leipzig Fair Agency in Great Britain, 127 Oxford-street, London, W.1. Tel. GERrard 0357.

Frankfurt International Autumn Fair.—Sun., Sept. 2, to Thurs., Sept. 6, at Frankfurt. *Agents:* Lep Transport, Ltd., Sunlight Wharf, Upper Thames-street, London, E.C.4. Tel. CENtral 5050.

***Statistical Mechanics of Transport Processes, Colloquium on.**—Mon., Sept. 3, to Fri., Sept. 7, at Brussels. Organised by the International Union of Pure and Applied Physics. Apply to Professor I. Prigogine, Université Libre de Bruxelles, 50 Avenue F. D. Roosevelt, Brussels, Belgium.

Farnborough Flying Display and Exhibition.—Mon., Sept. 3, to Sun., Sept. 9, at Farnborough, Hampshire. Open to the public on Fri., Sat., and Sun., Sept. 7, 8 and 9, only. Organised by the Society of British Aircraft Constructors, Ltd., 29 King-street, London, S.W.1. Tel. TRAfalgar 3231.

***History of Science, Eighth International Congress on, and Fourth General Assembly of the International Union for the History of Science.**—Mon., Sept. 3, to Mon., Sept. 10, at Florence and Milan. Apply to Professor Vasco Ronchi, Istituto Nazionale di Ottica, Via San Leonardo 79, Florence, Italy.

***Human Relations, Research into Factors Influencing.**—Mon., Sept. 3, to Sat., Sept. 15, at Bergen Dal, near Nijmegen, Holland. Apply to the conference secretariat, Raamweg 44, The Hague, Holland.

British Mathematical Colloquium, Eighth.—Tues., Sept. 4, to Thurs., Sept. 6, at St. Andrews. Apply to Mr. D. Borwein, Department of Mathematics, St. Salvator's College, St. Andrews, Scotland.

***Fluid Mechanics Symposium.**—Wed., Sept. 5, to Fri., Sept. 7, at Göttingen, Germany. Organised by the International Union of Theoretical and Applied Mechanics. Apply to the Union' ssecretary, Professor F. H. van den Dungen, 41 Avenue de l'Arbelète, Boitsfort, Brussels, Belgium.

Applied Mechanics, Ninth International Congress.—Wed., Sept. 5, to Thurs., Sept. 13, at Brussels. Apply to the general secretariat, Université Libre de Bruxelles, 50 Avenue F. D. Roosevelt, Brussels, Belgium.

Radio and Television Exhibition.—Wed., Sept. 5, to Sat., Sept. 15, in Paris. Organised by the Syndicat des Constructeurs d'Appareils Radio Recepteurs et Televiseurs, 23 Rue de Lubeck, Paris, 16e.

Handicrafts, Homecrafts and Hobbies Exhibition.—Thurs., Sept. 6, to Fri., Sept. 21, at Olympia, London, W.14. Apply to the exhibition organiser, 24 Store-street, London, W.C.1. Tel MUSeum 9792.

Cologne International Autumn Fair.—*Household goods and hardware:* Fri., Sept. 7, to Sun., Sept. 9, at Cologne. *Textiles and clothing:* Sun., Sept. 16, to Tues., Sept. 18, at Cologne. *Agent:* Mr. Neven du Mont, 123 Pall Mall, London, S.W.1. Tel. WHItehall 8211.

Levant Trade Fair, 20th.—Fri., Sept. 7, to Tues., Sept. 25, at Bari. Apply to the Italian Chamber of Commerce for Great Britain and the Commonwealth, 652 Grand Buildings, Trafalgar-square, London, W.C.2. Tel. WHItehall 5521.

Ghent Fair, 11th International.—Sat., Sept. 8, to Sun., Sept. 23, at Ghent, Belgium. *Agents:* S. R. Tippett & Co., Ltd., 110 Cannon-street, London, E.C.4. (Tel. MANsion House 4500); and Robertson, Buckley & Co., Ltd., Berey's Buildings, George-street, Liverpool (Tel. Central 0952).

Swiss National Autumn Fair (Comptoir Suisse).—Sat., Sept. 8, to Sun., Sept. 23, at Lausanne. Apply to the commercial secretary, Swiss Legation, 18 Montague-place, Bryanston-square, London, W.1. Tel. PADdington 0701.

German Agricultural Show.—Sun., Sept. 9, to Sun., Sept. 16, at Hanover. Apply to the Deutsche Landwirtschafts-Gesellschaft, Niedenau 48, Frankfurt-on-Main.

***Analytical Chemistry Congress (15th International Congress of Pure and Applied Chemistry).**—Sun., Sept. 9, to Sun., Sept. 16, at Lisbon, Portugal. Apply to Mr. P. A. Laurent, Istituto Superior Tecnico, Avenida Rovisco Pais, Lisbon, Portugal.

Electron Transport in Metals, Symposium on.—Mon., Sept. 10, to Fri., Sept. 14, at Ottawa, Canada. Apply to Professor P. Fleury, International Union of Pure and Applied Physics, 3 Boulevard Pasteur, Paris 15e.

High-Speed Photography, Third International Congress and Exhibition.—Mon., Sept. 10, to Sat., Sept. 15, at Government Offices, Horse Guards-avenue, London, S.W.1. Sponsored by the Department of Scientific and Industrial Research. Apply to the Congress Secretariat, D.S.I.R., Charles House, 5-11 Regent-street, London, S.W.1. Tel. WHItehall 9788. See ENGINEERING, November 11, 1955, page 671.

Fishery Equipment Exhibition, International.—Sat., Sept. 15, to Sat., Sept. 22, at Istanbul, Turkey. Organised by the Government of Turkey to coincide with the fourth meeting of the General Fisheries Council for the Mediterranean to be held at Istanbul from Sept. 17 to 22. The Council is sponsored by the Food and Agriculture Organisation of the United Nations. Apply to Mr. Cihat Renda, Meat and Fish Office, Selanik Cad. 78, Ankara, Turkey.

***Measurements and Instruments, Conference and Exhibition.**—Sat., Sept. 15, to Sun., Sept. 23, at Stockholm. Particulars of conference obtainable from Mr. Sven Malström, Box 12035, Stockholm 12; and of exhibition from Anders Beckman Inc., Smalandsgaten 2, Stockholm.

***Electrochemical Thermodynamics and Kinetics, Eighth Annual Meeting of the International Committee on.**—Sun., Sept. 16, to Thurs., Sept. 20, at Madrid. Organised by the Comité International de Thermodynamique et de Cinétique électrochimiques. Apply to the Committee's secretary-general, Dr. M. Pourbaix, 50 Avenue Franklin Roosevelt, Brussels, Belgium.

***Electron-Microscopy, European Regional Congress on.**—Mon., Sept. 17, to Thurs., Sept. 20, at Stockholm. Apply to Mr. J. Rodin, Karolinska Institutet, Stockholm, Sweden.

***International Astronautical Federation, Seventh Annual Congress on.**—Mon., Sept. 17, to Sat., Sept. 22, at Rome. Apply to Mr. J. A. Stemmer, International Astronautical Federation, P.O. Box 37, Baden, Germany.

***Institute of Metals Autumn Meeting.**—Mon., Sept. 17, to Tues., Sept. 25, at Stuttgart and Frankfurt. Organised by the Institute of Metals, 17 Belgrave-square, London, S.W.1. Tel. BELgravia 3291.

***Automatic Computing, Cambridge Summer School on.**—Mon., Sept. 17, to Fri., Sept. 28, at Cambridge. Apply to Mr. G. F. Hickson, secretary, Board of Extra-Mural Studies, Stuart House, Cambridge.

***Fire Prevention and Extinction, Meeting of the International Technical Committee for.**—Thurs., Sept. 20, to Sun., Sept. 30, at Rome. Apply to Dr. Ing. F. Cini, Commandante le Scuole Centrale dei Servizi Anticendi, Capanelle, Rome.

***Automatic Controls, Conference on.**—Tues., Sept. 25, to Fri., Sept. 28, at Heidelberg, Germany. Apply to the secretary-general, V.D.I./V.D.E. Fachgruppe Regelungstechnik, Haus 35, Hertzstrasse 16, Karlsruhe, Germany.

Business Efficiency Exhibition.—Tues., Sept. 25, to Fri., Sept. 28, at St. Mary's Drill Hall, Southampton. Organised by the Office Appliance and Business Equipment Trades Association, 11–13 Dowgate-hill, Cannon-street, London, E.C.4. Tel. CENtral 7771.

***Direction of Research Establishments, International Symposium on.**—Wed., Sept. 26, to Fri., Sept. 28, at the National Physical Laboratory, Teddington, Middlesex. Organised by the N.P.L. Apply to Mr. E. S. Hiscocks, secretary, National Physical Laboratory, Teddington. See ENGINEERING, July 13, page 39.

***Chemical Engineering, Tenth Meeting of European Federation of.**—Mon., Oct. 1, to Wed., Oct. 3, at Hamburg. Organised by the European Federation of Chemical Engineering, Frankfurt-am-Main, West Germany.

***Atomic Energy Course for Management.**—Mon., Oct. 1, to Fri., Oct. 5, at the Biltmore Hotel, New York. Organised by the National Industrial Conference Board, 460 Park-avenue, New York 22.

***Traffic Engineering, International Study Week on.**—Mon., Oct. 1, to Sat., Oct. 6, at Stresa. Held with the co-operation of the International Road Federation and various Italian organisations. Particulars available from the World Touring and Automobile Organisation, 32 Chesham-place, London, S.W.1. Tel. SLOane 0386.

***Weights and Measures, Meeting of International Committee on.**—Mon., Oct. 1, to Wed., Oct. 10, at Paris. Organised by the Bureau International des Poids et Mesures, Pavilion de Breteuil, Sèvres (Seine et Oise), France.

Motor and Cycle Show.—Thurs., Oct. 4, to Sun., Oct. 14, in Paris. *Representative:* R. C. Liebman, 178 Fleet-street, London, E.C.4. Tel. CITy 5889.

Engineering Industries Association: London Regional Display.—Wed., Oct. 10, to Fri., Oct. 12, at the Royal Horticultural Society's New Hall, Greycoat-street, London, S.W.1. Apply to the secretary of the Association, 9 Seymour-street, London, W.1. Tel. WELbeck 2241.

Building Trades Exhibition.—Tues., Oct. 16, to Sat., Oct. 27, at Manchester. Organised by Provincial Exhibitions, Ltd., City Hall, Deansgate, Manchester, 3. Tel. Deansgate 6363.

Knitting Machinery and Accessories Exhibition.—Wed., Oct. 17, to Sat., Oct. 27, at Leicester. Organised by Textile Recorder Exhibitions Ltd., Old Colony House, South King-street, Manchester 2. Tel. Blackfriars 7234.

Charleroi Trade Fair.—Oct. 27 to Nov. 11, at Charleroi, Belgium. *Agent:* Mr. Vincent Caers, 67 Rugby-avenue, Wembley, Middlesex. Tel. Wembley 0975.

***Canadian National Packaging Exhibition.**—Tues., Nov. 6, to Thurs., Nov. 8, at Toronto. Organised by the Packaging Association of Canada, 1 St. Clair-avenue West, Toronto 7.

***Chemical Sciences Convention.**—Sun., Nov. 18, to Mon., Dec. 3, in Paris. Convention will include the
29th International Congress of Industrial Chemistry, Sun., Nov. 18, to Sat., Nov. 24, at 28 Rue Saint-Dominique, Paris 7e;
First European Congress on Corrosion, Sun, Nov. 18, to Sat., Nov. 24, at 28 Rue Saint-Dominique, Paris 7e;
European Conference on Chemical Engineering, Thurs., Nov. 22, to Sat., Nov. 24, at the Palais des Congrès, Porte de Versailles, Paris; and
Technical Meetings on such subjects as Plastics, Rubber and Special Steels, Mon., Nov. 26, to Fri., Nov. 30, and Mon., Dec. 3, at the Palais de Congrès, Porte de Versailles, Paris.
Apply in each case, to the Société de Chimie Industrielle, 28 Rue Saint-Dominique, Paris 7e.

***Chemical Industry, Rubber and Plastics Exhibition.**—Thurs., Nov. 22, to Mon., Dec. 3, at the Parc des Expositions, Porte de Versailles, Paris. Offices: 28 Rue Saint-Dominique, Paris 7e. *Agents:* Butler's Advertising Service, 22 St. Giles High-street, London, W.C.2. Tel. TEMple Bar 5905.

***Mechanical Engineers' Contribution to Clean Air, Conference on.**—Tues., Feb. 19, to Thurs., Feb. 21, 1957, in London. Organised by the Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. Tel. WHItehall 7476.

***Metals under High Rates of Strain, Conference on.**—In March, 1957, probably in London. Organised by the Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. Tel. WHItehall 7476.

***Physical Society's Exhibition of Scientific Instruments and Apparatus.**—Mon., Mar. 25, to Thurs., Mar. 28, 1957, in the Royal Horticultural Society's Old and New Halls, Vincent-square and Greycoat-street, London, S.W.1. Organised by the Physical Society, 1 Lowther-gardens, Prince Consort-road, London, S.W.7. Tel. KENsington 0048.

***Radio Component Show, 14th.**—Tues., April 9, to Thurs., April 11, 1957, at Grosvenor House, Park-lane, London, W.1. Pre-view for overseas and special guests on Mon., April 8. Annual private exhibition organised by the Radio and Electronic Component Manufacturers' Federation, 21 Tothill-street, London, S.W.1. (Tel. ABBey 4226.) Applications for admission must be made in advance.

***Chemical Engineering Education Symposium.**—Tues., April 9, to Thurs., April 11, 1957, at The University, Birmingham. Organised by the Midlands Branch, Institution of Chemical Engineers. Apply to the secretary of the Institution, 56 Victoria-street, London, S.W.1. Tel. VICtoria 6161.

United States World Trade Fair.—Sun., April 14, to Sat., April 27, 1957, at the New York Coliseum, New York. Managers: The Charles Snitow Organisation, Inc., 331 Madison-avenue, New York 17. Information may be obtained from the British Commonwealth Chamber of Commerce in the United States, 677 Fifth-avenue, New York, 22; and from the Fair's British and Commonwealth Office, Dudley House, 36 and 38 Southampton-street, London, W.C.2. Tel. TEMple Bar 8947.

***Industrial Tool and Production Show of Canada.**—Mon., April 22, to Fri., April 26, 1957, in the Industry Building, Exhibition Park, Toronto. Apply to Mr. E. M. Wilcox, 19 Melinda-street, Toronto, Canada.

***Factory Equipment Exhibition, Fifth.**—Mon., April 29, to Sat., May 4, 1957, at Earl's Court, London, S.W.5. Theme: "Greater Efficiency in Industry." Organised by Factory Equipment Exhibitions, Ltd., 4 Snow-hill, Holborn-viaduct, London, E.C.1. Tel. CENtral 0354.

***British Industries Fair.**—Mon., May 6, to Fri., May 17, 1957, in the B.I.F. Buildings, Castle Bromwich, Birmingham. Organised and controlled by the Birmingham Chamber of Commerce. Apply to the organisers: P.O. Box 6, 95 New-street, Birmingham 2. Tel. Midland 5021.

***Instruments, Electronics and Automation Exhibition, First.**—Tues., May 7, to Fri., May 17, 1957, at Olympia, London, W.14. Promoted by the British Electrical and Allied Manufacturers' Association and four other trade associations. Organised by Industrial Exhibitions, Ltd., 105-106 New Bond-street, London, W.1. Tel. HYDe Park 9583.

***Commonwealth Mining and Metallurgical Congress, Sixth.**—Sun., Sept. 8, to Wed., Oct. 9, 1957, at Vancouver, British Columbia, and other centres in Canada. Apply to the congress secretary, 507 Metropolitan Building, 837 West Hasting-street, Vancouver 1, B.C., Canada.

***Fishing Gear, International Congress on.**—In October, 1957, at Hamburg, Germany. Organised by the Food and Agriculture Organization of the United Nations, Viale delle Terme di Caracalla, Rome. See ENGINEERING, July 13, 1956, page 38.

In Parliament

£235 MILLION ON RESEARCH

Some further amendments were made last week to the Department of Scientific and Industrial Research Bill on its re-submission to the House of Commons from the Lords, and the Bill was then passed through its remaining stages.

One amendment, moved by Mr. J. R. Bevins, the Parliamentary Secretary to the Ministry of Works, provided that, in exercising their functions, the new Research Council, which the Bill will bring into being, " shall have regard, consistently with the national interest, to similar or related activities carried on by other persons." The aim of the amendment, Mr. Bevins explained, was to ensure that there was effective co-operation by the Department of Scientific and Industrial Research with research work elsewhere so as to avoid undesirable overlapping. The words " consistently with the national interest " had been inserted because circumstances might arise where the national interest would dictate that the Department should concern itself in a particular section of research even though others were engaged upon it.

In the ensuing debate, Mr. James Callaghan (Labour) said he had thought at one stage that the amendment might be an attempt to cut down the work of the Department in cases where research was being undertaken by private firms and industries outside, but he now gathered that that was not so. The doubt had arisen in his mind because of the illustration he had given on a previous occasion of the work done on polymers in chemical research laboratories, which had been challenged by private industry proceeding on similar lines. It had been challenged, he thought, not because private industry had a real desire to avoid overlapping, but because it did not want trade secrets to get out and be widely spread.

No less than £235 million was being spent by Britain on research this year and, out of that sum, the D.S.I.R. was responsible for no more than £10 million. The great bulk of that expenditure was on the defence side. The Minister of Supply was probably the man more responsible for research expenditure than any other one person in Britain at the present time. The real difficulty in respect of scientific co-ordination was not that the Services were uninterested in scientific development, but that they were obsessed with it. It might well be that, as had been said of the attitude of the American Chiefs of Staff to research, our own Services got on their horses and galloped off in all directions at once.

IGNORANCE OF RESEARCH WORK

Another amendment approved provided that the Department should " take steps to further the practical application of the results of scientific and of industrial research." Mr. Bevins pointed out that the question had been raised in previous debates on the Bill as to whether the Department was giving adequate practical effect to the recommendation of the Advisory Council on Scientific Policy that greater use ought to be made by Government Departments and research associations of the technique of development contracts, in order to make sure that the results of research were brought into use promptly. The amendment had been very widely drawn so as to cover all development work and contracts ever undertaken, whether or not they would lead to inventions. This addition to the Bill should make it clear, beyond all doubt, that the Department had important responsibilities in the stages of research between the laboratory and actual production. Whether or not enough was now being done in that direction would be one of the most important subjects to receive the attention of the Research Council when it was formed.

Mr. Callaghan said that one of the major troubles of British industry at the present day was that there existed so many firms of so small a size that they were quite unable to employ scientists or technologists to any degree. In many cases, these firms were not only incapable of absorbing the latest scientific and technical developments, but they did not even know that such developments existed. The amendment would give the Government, if they were so minded, the opportunity of spreading the great benefits to be derived from modern scientific and technological developments among a wide range of small and medium-sized British firms.

The Opposition was anxious that this work should be undertaken on a large scale, so that the Department could become responsible for entering on development in such a way that these many small and medium-sized firms, which represented the greater part of British industry, could take up projects which were known to exist, but which these small companies had not the necessary technical resources to utilise.

FARADAY'S ERA GONE

The view was expressed by Mr. Chuter Ede (Labour) that research had now reached the stage where only Governments or wealthy corporations could indulge in it. The time had passed when Priestley and Cavendish could carry out revolutionary experiments with home-made apparatus. Even Faraday and Davy, and others of their generation, were able to conduct researches with their own finances and according to their own human ingenuity.

In these days, Lever Brothers and Imperial Chemical Industries and similar firms might be able to carry on research, but even the universities could not undertake it except with the aid of substantial grants from the Government. Furthermore, the universities accepted those grants, although, not so very long ago, such action would have been considered a very dangerous thing for a university in this country to do.

Sir Hugh Linstead (Conservative) said that the duty of the Government and of the D.S.I.R. would seem to be that of selecting likely pieces of research in the laboratory stage and then, if these were not being taken up by industry, of making certain that they were carried to the pilot or development stage, in order that their potentialities on a manufacturing level might be assessed. He thought that the Government could hardly go beyond that. If British industry did not have the initiative and vision to take over from that stage, so much the worse for industry and the country. Mr. Callaghan suggested that changing an advisory research council into a part-time executive Research Council, composed mostly of very similar people, was hardly likely to prove a revolutionary change.

Replying to some of the points raised, Mr. Bevins said that the D.S.I.R. had maintained liaisons with the research associations, which were, indeed, autonomous bodies, and had been ensuring that development work had not overlapped. He believed he was right in stating that development contracts had been given in one or two cases to industrial firms. It was the intention of the Government that the new Council, which would be set up towards the autumn, should be so constituted that, in practice, its members would be able to give a good deal of their time to it, both collectively and as individuals with specialist responsibilities. He undertook that consideration should be given to a suggestion that the first report of the new Council should contain a special section devoted to what use it had made of its newly-conferred powers of furthering the results of research.

Mr. Austen Albu (Labour), who brought the debate to a close, laid special emphasis on the importance of resisting economies in the work of the Department. When Britain, like other countries, was so short of the best scientific brain power, it was essential that research workers, in particular, were not starved of the technical, laboratory and typing assistance they required.

Merchant Ship Construction

In reply to Mr. Paul Williams (Conservative), who asked for information about recent shipbuilding progress in Britain, Mr. S. Wingfield Digby, the Civil Lord of the Admiralty, said that about 804,000 gross tons of merchant shipping were completed in British shipyards during the first half of 1956, compared with some 660,000 gross tons during the comparable period of 1955. In so far as the North-East Coast area was concerned, about 310,000 gross tons were completed in the first half of this year. The comparative figure for the corresponding period of last year was 241,000 gross tons.

Capital Investments Increasing

Mr. J. Grimond (Liberal) raised the question of the likely trend of capital investment by British industrialists during the immediate future. He was informed by Mr. Peter Thorneycroft, the President of the Board of Trade, that, as a result of inquiries by his Department, forecasts of fixed capital expenditure to be undertaken during 1956 showed that industrialists expected to invest about 20 per cent. more in this connection than they did last year. Information on this matter had been published in the *Board of Trade Journal* for July 7 last. Preliminary estimates of capital expenditure during 1957 were now being received, but sufficient information was not yet available, Mr. Thorneycroft said, to enable him to make an estimate of what industrialists expected to invest next year. An estimate would be published as soon as possible.

Science Graduates for Teaching

A more hopeful outlook in regard to overcoming the present shortage of science teachers was indicated by Sir David Eccles, the Minister of Education, in an answer to Mr. S. S. Awbery (Labour). After pointing out that this topic was discussed at some length in chapter II of his Ministry's report for 1955, Sir David said that he could not indicate when the supply of science teachers would match the demand. Between six and seven hundred graduates in science and mathematics were preparing at university departments of education, for teaching careers. About 500 other graduates in these subjects were likely to enter the schools this autumn. Furthermore, 215 students had enrolled at training colleges for third-year courses in science and mathematics, compared with only 59 a year ago. The new salary scales for teachers were likely to have a stimulating effect on recruitment.

River Thames Flood Barrier ?

Arising out of proposals contained in the report of the Committee on Coastal Flooding, Mr. Duncan Sandys, the Minister of Housing and Local Government, has had a preliminary survey made into the possibility of preventing flooding in the Thames Valley. The alternatives of raising the river banks or of erecting some form of structure across the river which could be closed against a tidal surge have been investigated. Mr. Sandys informed Mr. P. F. Remnant (Conservative) that, as a result of these inquiries, he had appointed two firms of consulting engineers to prepare a joint report on the practicability, design and estimated cost of constructing a movable flood barrier at a suitable point on the river.

Road Journeys of Combine Harvesters

Difficulties experienced in the moving of heavy plant by road were brought to the attention of the House by Sir W. Anstruther-Gray (Conservative), who asked the Minister of Transport and Civil Aviation if he would reconsider the regulation which requires 24 hours' notice to be given to the police before harvesters are allowed to travel along public roads, in view of the fact that changeable weather renders the regulation impracticable. In reply, Mr. Harold Watkinson said that, at the present time, such notice was only required to be given if the harvester was more than 8 ft. wide and the road journey exceeded five miles. He had these and other requirements under review, and he was proposing to amend them, so that, in future, no notice was needed in respect of harvesters up to 9 ft. 6 in. in width.

THE HUMAN ELEMENT

The social unit in industry—Unionisation to uphold professional status—A win in spite of indifference—Spirals in the Antipodes—A clear warning—Expensive advertisement.

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Human Relations in 1955

There was a definite increase in the tendency for companies to analyse more fully the causes of industrial unrest in 1955, according to the annual report of the Ministry of Labour issued last week. Training received more attention but there was a dearth of training officers. There were indications that consultation was becoming more realistic and effective within companies and there were signs of growing interest in co-partnership schemes. More concerns seemed prepared to give employees information about finance and trading prospects.

Notable features were the increasing caution in adopting incentive schemes, and a movement away from indidivual bonus schemes to the group variety. In so far as this represents a move from hastily conceived bonus arrangements and the adoption of ready-made formulas it is to be welcomed. Most circumstances benefit from work study before they can be harnessed to some bonus incentive scheme. The growing popularity of group schemes is partly due to the much greater emphasis which has been placed in recent years in industry on the working group as a social unit. There is much to be said in favour of this approach. On the other hand, the larger a group becomes the less are its individual members likely to respond to financial incentives. It is a question which as yet defies answer whether industry will benefit most from workers happily associated within a group or from those open to the largest money incentive. The answer, when it is found, will probably lie somewhere between the two.

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Engineers in America

Concern has been expressed by the Engineers Joint Council in the United States about the standing of engineers as professional men. The Council is a federation of engineering societies with a combined membership of over 200,000. The problem has been analysed in a pamphlet called "Raising Professional Standards and Improving Employment Conditions for Engineers."

According to the pamphlet, the failure of employers to recognise adequately the position of professional engineers has led to a degree of unionisation which is not in the professional interests of engineers as a whole. Part of the problem has risen from the rapid rate of unionisation in the United States since the passing of the Wagner Act in 1935. The sheer pace of growth has tended to be rather sweeping. There are other causes, however, which have a familiar ring in this country. The Council's views on these can be summed up as follows. The professional engineer's position is not adequately recognised by top management and his remuneration has not kept pace either with the contribution which he makes to an increasingly mechanical age or with the rates paid to wage earners.

The Council concludes that engineers' services should be used more effectively by management, that the managerial functions of engineers should be more fully admitted and that engineers should re-assess their own professional conduct, a move which should be supported by the establishment of high professional standards by engineering societies. A word is also put in for inculcating the importance of professional standards and ethics by those responsible for training young engineers. In other words, the challenge to-day to the professional engineer comes from mechanisation as well as from taxation.

* * *

Communist Defeat in A.E.U.

Steel has had a lot to do with the latest surprise result in the voting in the A.E.U. A non-Communist, Mr. P. Hanley, has won the seat for the Eastern division of the union vacated by Mr. Carron on his elevation to the presidency. Few fancied the chances of a non-Communist getting in at Sheffield which is reckoned to be one of the comrades' strongholds.

It all seems to have been brought about by the Man of Steel's wilted reputation in the Steel City. The result indicates that the Communists were singularly unable to get out their vote which suggests that fellow-travellers have been taken aback by Stalin's excommunication from the Communist hall of fame. It would be comforting to be able to say that the election for the Eastern division, which was featured at the time in a much criticised television programme, had been decisively affected by the publicity. True, the poll was up by about 10 per cent., but even at that the total which turned out was only 9¾ per cent. of the membership. It will take more than one isolated radio performance to destroy indifference.

Meanwhile, the influence of the Communists on the A.E.U. has suffered a decisive setback. It suggests that these days of bewilderment among the faithful are the tactical moment for a non-Communist offensive in the trade-union world. It is indeed doubtful if publicity alone can do much in the right direction. Enthusiasm to participate in an organisation's activities is rarely generated by telling people that they ought to do more. The Communist challenge, so eloquently underlined by a paltry 10 per cent. turnout at the ballot box, is directed in effect at trade union organisation. "Bigness" is a problem which affects the unions to-day as well as companies. They urgently need to find ways of generating enthusiasm in their administrative work and among their members. It might not be going too far to say that some of the thought which has been given to the problems of the large organisation should now be extended to the trade union movement.

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Australian Wages

The spiral of prices and wages is gathering momentum in Australia. During the quarter ended June 30 the cost of living rose by an average of 6*s.* a week and the basic wage for workers who are subject to cost-of-living adjustments rose to about £A13 a week. The new basic wage, which varies from £A11 17*s.* in Brisbane to £A13 13*s.* in Perth, reflects the seventh quarterly rise in cost-of-living figures. According to the Commonwealth Statistician, commodities which could be bought for 7*s.* 3*d.* in September, 1939, now cost £A1.

There is a great deal of concern over the progress of inflation, and the acting Prime Minister, Sir Arthur Fadden, has called a special conference of the Premiers of each State to discuss a uniform wage policy. This would seem an odd time to introduce an element in the situation which can hardly make for high productivity and high production, the best of all anti-inflationary weapons. Sir Arthur's bluntness in referring to the problems he wishes to discuss as "the impact of current industrial and wage problems on the economic situation" could be the start of a bout of labour unrest which the Government might find difficult to control.

The urgency of the introduction of a national wage policy is said to result from the increasing disparity in the wages in different States. At the last Premiers' conference in June it was decided to discuss this problem, which has now become more acute. A new conference was being called earlier than had been planned because, Sir Arthur said, of the chaos to which the wage determination system had degenerated. The leader of the opposition, Dr. Evatt, takes an equally serious view of the situation but advocates that Parliament should be called to consider suitable emergency measures which could constitute "a genuine attempt to stabilise the economy."

* * *

The Government and the N.F.U.

There was a vigorous exchange last week in the House between the Minister of Agriculture, Mr. Heathcoat Amory, and Labour members on the subject of agricultural wages. Mr. Amory sent a letter to the National Farmers Union in which he is said to have informed them that any wage increase agreed to at the meetings of the Agricultural Wages Board would not necessarily cause him to give full recoupment in a special review of agricultural prices. The Opposition took the line that this was a complete departure from the principle of Ministerial impartiality in wage disputes, and constituted a completely unwarranted interference in the workings of the Agricultural Wages Board. Mr. Percy Wells, Labour, who raised the matter, argued that agricultural wages were "miserably low" at 135*s.* a week, and that in their efforts to improve their lot they would have not only the N.F.U. to deal with but the Government also.

Mr. Amory defended his action on the grounds that it was his duty to inform the wages board of "the current relevant factors, including the need for restraint in wages and prices," and that his letter in no way prejudiced the impartial consideration of the claims made by the farm workers. This is as may be, but Mr. Amory's intervention was clearly in support of the Government's policy of wage and price restraint. It is the first time such a directive has been issued, and it is unlikely to be the last. In the N.F.U.'s case, however, the Government control agricultural prices, by the amount of subsidy they give farmers, and the intervention will therefore have very special weight. The implications of the Government's action—it could mean a direct clash with organised labour—are not very pleasant ones.

* * *

The Wrong Kind of Publicity

Rarely, if ever, can one of the leaders in the engineering industry have had his private life so glaringly exposed in public as has Sir Bernard Docker, the recently deposed chairman and managing director of the Birmingham Small Arms Company, Limited. The case that his ex-colleagues have presented against him is based mainly on allegations of extravagance and nepotism. His remuneration and expenses from the B.S.A. group for the year ending July 31, 1955, amounted to over £44,000; he directed the company should spend over £50,000 on building five luxury Daimler cars; he attempted to get the company to settle a bill amounting to nearly £8,000 for furs and clothes worn by Lady Docker; etc., etc.

Sir Bernard replied to the charges in a circular to shareholders and hit hard at his former colleagues. The gold and other special cars were, he argues, first-rate publicity bought cheap at the price. The furs and the clothes were necessary to achieve the same purpose. His salary of £24,000 as managing director began in 1954 after 14 years' service without a salary and two years at £5,000. The Paris showrooms now operating at a loss could be sold at a large profit.

The popular Press has relished this story, so presumably have its readers. Now, at last, we see that the English can be second to none—not even to Americans—in flamboyance and showmanship. It might have been good for business, in a world where show and success are closely linked, but it is not in the best traditions of British Businessmanship. It did not ring true. So Sir Bernard will probably lose his battle, for shareholders tend to prefer a genteel reticence to extravaganza on the part of their paid executives.

XUM